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EVALUATION OF IR COUNTERMEASURES OH-58 (SCOUT) MODEL REPORT.(U)
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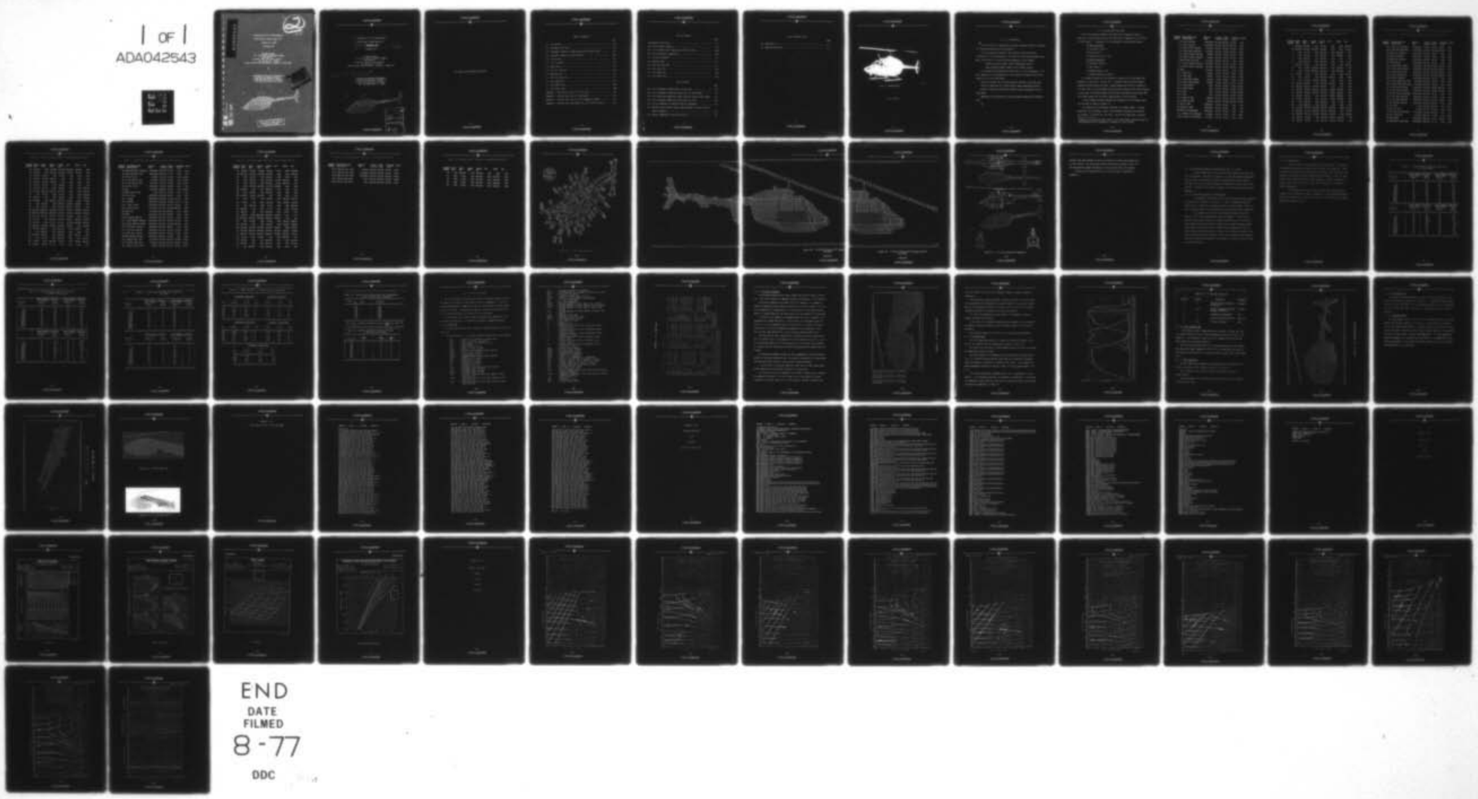

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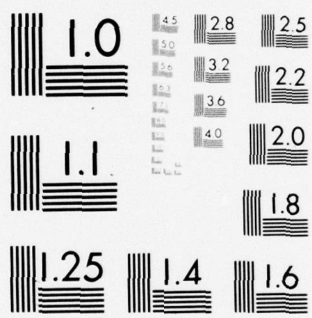

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Evaluation of IR Countermeasures

OH-58 (Scout) Model Report (U)

October 16, 1973

Prepared for

Program Manager
U.S. Army Aviation Systems Command
AMCPM-AEWSPS
Box 209, 12th and Spruce Street
St. Louis, Mo. 63166
Under Contract DAAJ01-72-C-0447, Exhibit A, Data A003

by

Westinghouse Electric Corporation
Systems Development Division
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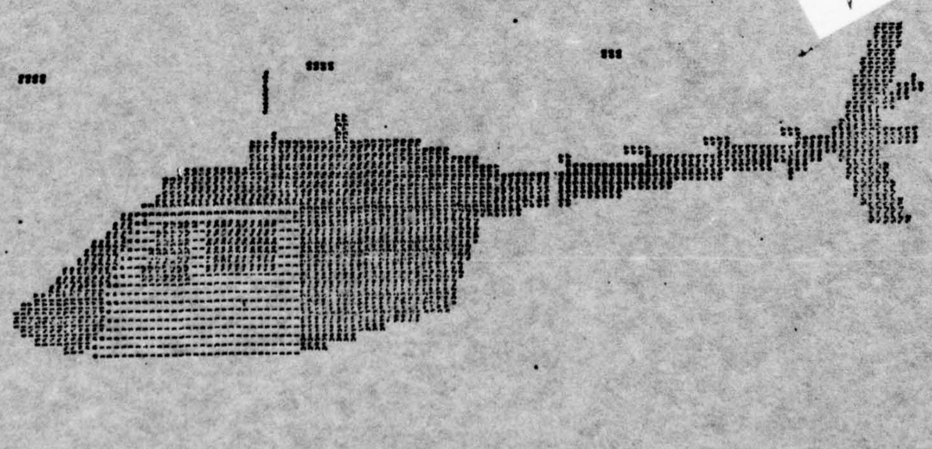

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RHD-10

Figure 1-1. OH-58A helicopter

OH-58 (Scout)

1.0 (U) INTRODUCTION

The HIDE model is a comprehensive computer program designed to simulate the infrared signatures of Army aircraft.

The HIDE model was developed under contract DAA-J01-72-C-0447, "Evaluation of IR Countermeasures", for the U.S. Army Aviation Systems Command, AMCPM-AEWSPS. This work has been reported in two volumes:

Interim Technical Report (Model Methodology) 6-26-72

Final Technical Report (Phase II HIDE Model) 2-28-73

The original work developed the signature of a UH-1H helicopter. The work reported her is an extention to this contract to model an OH-58 helicopter to run in the HIDE model.

Section 2 defines the structural modeling referred to as body data.

Section 3 describes the turbine and air frame operational models.

Section 4 presents a predicted signature after integration into the HIDE model.

Appendices are included which contain program elements and reference data.

2.0 (U) HELICOPTER BODY DATA

The OH-58 body was dissected into eighty (80) surfaces as shown in Table 2-1. The technique used was that described in Appendix A of the Phase II Final Report.[1] A breakdown of the helicopter by surface types shows:

43 flats including:

17 rectangles (type 1),

3 discs (type 2),

23 trapesoids (type 3), and

37 conics including:

20 cylinders (type 4),

5 cones (type 5),

12 spheres (type 6), and

0 circular parabolids (type 7).

An isometric drawing of the helicopter showing how the helicopter was dissected is presented in figure 2-1. A numbered baloon for each surface indicates surface number and type. Dashed baloons are used for surfaces on the right side of the helicopter which are mirror images of left side surfaces. In each case, the surface number for the right side surface is one higher than the surface number for the mirror image surface on the left side.

A large computer printout showing the helicopter at a 70° aspect angle off the nose is shown in figure 2-2.

The numbers on the helicopter represent the surface number. Certain areas such as the windows, rotors, and horizontal stabilizer are outlined for clarity. In figure 2-3, the front, top and side views from a computer

[1] Evaluation of Countermeasures, Phase II HIDE Model Final Technical Report by Westinghouse Electric Corporation, February 28, 1972 (Secret)

Table 2-1. OH-58 Helicopter Geometrical Structure Data

SURFACE NUMBER	HELICOPTER PART DESCRIPTION	SURFACE TYPE	FLIGHT STATION	WATER-LINE	BULKHEAD LINE	ALPHA
1	L. SIDE FUSELAGE	TRAPESOID	-121.000	192.900	26.000	.000
2	R. SIDE FUSELAGE	TRAPESOID	-121.000	192.900	-26.000	.000
3	L. UPPER SIDE FUSELAGE	CYLINDER	-59.200	65.000	19.000	7.000
4	R. UPPER SIDE FUSELAGE	CYLINDER	-59.200	65.000	-19.000	7.000
5	L. UPPER CORNER FUSELAGE	SPHERE	-59.200	65.000	19.000	7.000
6	R. UPPER CORNER FUSELAGE	SPHERE	-59.200	65.000	-19.000	7.000
7	UPPER FRONT FUSELAGE	CYLINDER	-59.200	65.000	.000	7.000
8	L. FRONT CORNER FUSELAGE	CYLINDER	-59.200	65.000	19.000	7.000
9	R. FRONT CORNER FUSELAGE	CYLINDER	-59.200	65.000	-19.000	7.000
10	NOSE	CYLINDER	-8.000	33.000	.000	7.000
11	L. SIDE NOSE	SPHERE	-8.000	33.000	7.000	7.000
12	R. SIDE NOSE	SPHERE	-8.000	33.000	-7.000	7.000
13	L. FRONT NOSE WINDOW	SPHERE	-8.000	33.000	7.000	7.000
14	R. FRONT NOSE WINDOW	SPHERE	-8.000	33.000	-7.000	7.000
15	L. NOSE WINDOW	CONE	21.000	33.000	2.000	13.400
16	R. NOSE WINDOW	CONE	21.000	33.000	-2.000	13.400
17	L. NOSE	CONE	21.000	33.000	2.000	13.400
18	R. NOSE	CONE	21.000	33.000	-2.000	13.400
19	L. REAR OF NOSE	SPHERE	-37.000	33.000	12.000	14.000
20	R. REAR OF NOSE	SPHERE	-37.000	33.000	-12.000	14.000
21	TOP OF NOSE	TRAPESOID	32.550	30.200	.000	.000
22	BOTTOM OF NOSE	TRAPESOID	32.550	35.900	.000	.000
23	FRONT OF WINDSHIELD	TRAPESOID	16.440	17.720	.000	.000
24	L. CORNER OF WINDSHIELD	CYLINDER	16.440	10.720	.000	7.000
25	R. CORNER OF WINDSHIELD	CYLINDER	16.440	10.720	.000	7.000

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Table 2-1. OH-58 Helicopter Geometrical Structure Data (Cont'd)

SURFACE NUMBER	BETA-MIN	BETA-MAX	GAMMA-MIN	GAMMA-MAX	PSI	THETA	PHI
1	127.900	173.900	.001	25.800	.000	.000	-90.000
2	-173.900	-127.900	154.200	180.000	.000	.000	90.000
3	.000	63.000	.001	360.000	.000	-90.000	.000
4	.000	63.000	.001	360.000	.000	-90.000	.000
5	.001	180.000	.001	360.000	.000	.000	.000
6	.001	180.000	.001	360.000	.000	.000	.000
7	-19.000	19.000	.001	360.000	.000	.000	90.000
8	.000	51.000	180.000	360.000	.000	154.200	.000
9	.000	51.000	180.000	360.000	.000	154.200	.000
10	-7.000	7.000	.001	360.000	.000	.000	90.000
11	.001	90.000	.001	180.000	90.000	.000	.000
12	.001	90.000	90.000	270.000	.000	.000	.000
13	90.000	180.000	.001	180.000	90.000	.000	.000
14	90.000	180.000	90.000	270.000	.000	.000	.000
15	29.400	58.800	180.000	360.000	-9.800	-90.000	.000
16	29.400	58.800	180.000	360.000	9.800	-90.000	.000
17	29.400	58.800	.001	180.000	-9.800	-90.000	.000
18	29.400	58.800	.001	180.000	9.800	-90.000	.000
19	.001	180.000	.001	360.000	.000	.000	.000
20	.001	180.000	.001	360.000	.000	.000	.000
21	-71.500	-41.700	170.890	189.110	-90.000	.000	-13.400
22	-71.500	-41.700	170.890	189.110	-90.000	.000	13.400
23	-88.900	-37.000	167.950	192.050	-90.000	.000	-36.500
24	38.250	90.900	.001	360.000	-12.050	-53.500	.000
25	38.250	90.900	.001	360.000	12.050	-53.500	.000

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Table 2-1. OH-58 Helicopter Geometrical Structure Data (Cont'd)

SURFACE NUMBER	HELICOPTER PART DESCRIPTION	SURFACE TYPE	FLIGHT STATION	WATER-LINE	BULKHEAD LINE	ALPHA
26	L. SIDE OF WINDSHIELD	TRAPESOID	-13.640	33.000	15.000	.000
27	R. SIDE OF WINDSHIELD	TRAPESOID	-13.640	33.000	-15.000	.000
28	BOTTOM OF FUSELAGE	RECTANGLE	-121.000	19.000	.000	.000
29	OVERHEAD WINDOWS	RECTANGLE	-59.200	72.000	.000	.000
30	FRONT TOP FUSELAGE	RECTANGLE	-59.200	72.010	.000	.000
31	TOP FUSELAGE	RECTANGLE	-121.000	72.000	.000	.000
32	L. FRONT DOOR WINDOW	TRAPEZOID	-86.280	110.750	26.010	.000
33	R. FRONT DOOR WINDOW	TRAPEZOID	-86.280	110.750	-26.010	.000
34	L. BACK DOOR WINDOW	RECTANGLE	-114.000	65.000	26.010	.000
35	R. BACK DOOR WINDOW	RECTANGLE	-114.000	65.000	-26.010	.000
36	REAR TOP FUSELAGE	TRAPEZOID	-200.600	79.500	.000	.000
37	L. REAR UPPER SIDE FUSE.	CYLINDER	-200.600	72.500	.000	7.000
38	R. REAR UPPER SIDE FUSE.	CYLINDER	-200.600	72.500	.000	7.000
39	L. MID SIDE FUSELAGE	TRAPEZOID	-468.500	98.800	-56.500	.000
40	R. MID SIDE FUSELAGE	TRAPEZOID	-468.500	98.800	56.500	.000
41	MID AFT BOTTOM FUSELAGE	TRAPEZOID	-230.500	45.450	.000	.000
42	L. AFT SIDE FUSELAGE	TRAPEZOID	-200.600	72.500	7.000	.000
43	R. AFT SIDE FUSELAGE	TRAPEZOID	-200.600	72.500	-7.000	.000
44	AFT BOTTOM FUSELAGE	TRAPEZOID	-229.550	140.300	.000	.000
45	TAIL BOOM	CONE	-475.600	105.400	.000	1.450
46	END TAIL BOOM	SPHERE	-377.660	93.550	.000	2.500
47	TAIL ROTOR DRIVE SHAFT	CYLINDER	-474.600	108.400	.000	.500
48	TAIL ROTOR HUB	CYLINDER	-352.180	96.180	.000	1.000
49	TAIL ROTOR	RECTANGLE	-352.180	96.180	10.400	.000
50	HORIZONTAL STABILIZER	RECTANGLE	-270.000	79.800	.000	.000

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Table 2-1. OH-58 Helicopter Geometrical Structure Data (Cont'd)

SURFACE NUMBER	BETA-MIN	BETA-MAX	GAMMA-MIN	GAMMA-MAX	PSI	THETA	PHI
26	-42.800	.000	144.380	180.000	-102.050	-90.000	.000
27	-42.800	.000	180.000	215.620	-77.950	90.000	.000
28	-26.000	26.000	.000	84.000	.000	.000	.000
29	-19.000	19.000	-22.000	.000	.000	.000	.000
30	-10.000	10.000	-22.000	.000	.000	.000	.000
31	-19.000	19.000	.000	39.800	.000	.000	.000
32	45.750	64.750	9.000	25.800	.000	.000	-90.000
33	-64.750	-45.750	154.200	171.000	.000	.000	90.000
34	.000	18.000	.000	30.000	.000	.000	-90.000
35	-18.000	.000	.000	30.000	.000	.000	90.000
36	-80.000	.000	166.630	193.370	90.000	.000	5.367
37	.000	84.000	.001	360.000	13.370	95.367	.000
38	.000	84.000	.001	360.000	-13.370	95.367	.000
39	-357.000	-292.200	167.590	174.750	90.000	90.000	-13.370
40	-357.000	-292.200	185.250	192.410	90.000	-90.000	-13.370
41	-112.400	-47.800	166.000	194.000	90.000	.000	13.100
42	-17.100	.000	113.750	174.750	90.000	90.000	-13.370
43	-17.100	.000	185.250	246.250	90.000	-90.000	-13.370
44	-115.900	-73.600	174.550	185.450	90.000	.000	66.900
45	98.500	300.000	.001	360.000	.000	96.817	.000
46	.001	180.000	.001	360.000	.000	.000	.000
47	125.000	300.000	.001	360.000	.000	95.367	.000
48	.000	10.400	.001	360.000	.000	.000	-90.000
49	-2.630	2.640	-31.000	31.000	.000	30.000	-90.000
50	-38.620	38.620	-18.000	.000	.000	.000	.000

Table 2-1. OH-58 Helicopter Geometrical Structure Data (Cont'd)

SURFACE NUMBER	HELICOPTER PART DESCRIPTION	SURFACE TYPE	FLIGHT STATION	WATER-LINE	BULKHEAD LINE	ALPHA
51	UPPER VERTICAL STABILIZ.	TRAPEZOID	-393.030	197.380	.000	.000
52	LOWER VERTICAL STAB	TRAPEZOID	-411.580	-14.200	.000	.000
53	FRONT OF SAIL	SPHERE	-73.000	72.000	.000	11.000
54	L. FWD SIDE OF SAIL	CYLINDER	-73.000	72.000	.000	11.000
55	R. FWD SIDE OF SAIL	CYLINDER	-73.000	72.000	.000	11.000
56	FWD TOP OF SAIL	TRAPEZOID	-73.000	83.000	.000	.000
57	SAIL	CYLINDER	-109.230	94.000	.000	10.000
58	FRONT TOP OF SAIL	DISC	-109.230	94.000	.000	.000
59	TOP OF SAIL	RECTANGLE	-109.230	94.000	.000	.000
60	L. INTAKE	RECTANGLE	-109.230	94.000	10.000	.000
61	R. INTAKE	RECTANGLE	-109.230	94.000	-10.000	.000
62	L. SIDE OF SAIL	RECTANGLE	-121.000	94.000	15.000	.000
63	R. SIDE OF SAIL	RECTANGLE	-121.000	94.000	-15.000	.000
64	ROTOR HUB	CYLINDER	-107.130	118.000	.000	1.250
65	ROTOR	RECTANGLE	-107.130	118.000	.000	.000
66	TOP ENGINE COWLING	TRAPEZOID	-221.000	94.000	.000	.000
67	L. SIDE ENGINE COWLING	RECTANGLE	-121.000	94.000	15.000	.000
68	R. SIDE ENGINE COWLING	RECTANGLE	-121.000	94.000	-15.000	.000
69	TOP AFT ENG. COWLING	TRAPEZOID	-215.840	80.840	.000	.000
70	L. AFT ENG. COWLING	TRAPEZOID	-240.200	75.000	-4.000	.000
71	R. AFT ENG. COWLING	TRAPEZOID	-240.200	75.000	4.000	.000
72	REAR ENGINE COWLING	RECTANGLE	-200.600	84.500	.000	.000
73	L. BOTTOM TAIL PIPE	CYLINDER	-138.000	100.000	13.500	3.000
74	R. BOTTOM TAIL PIPE	CYLINDER	-138.000	100.000	-13.500	3.000
75	L. BEND IN TAIL PIPE	SPHERE	-138.000	100.000	13.500	3.000

Table 2-1. OH-58 Helicopter Geometrical Structure Data (Cont'd)

SURFACE NUMBER	BETA-MIN	BETA-MAX	GAMMA-MIN	GAMMA-MAX	PSI	THETA	PHI
51	66.300	111.200	16.000	25.000	.000	.000	-90.000
52	-106.200	-77.080	146.500	155.000	.000	.000	-90.000
53	.001	90.000	.001	180.000	.000	.000	.000
54	.000	53.100	.001	360.000	-4.700	-90.000	.000
55	.000	53.100	.001	360.000	4.700	-90.000	.000
56	.000	49.000	175.300	184.700	-90.000	.000	.000
57	-15.000	.000	.001	360.000	.000	.000	.000
58	.000	15.000	.001	180.000	.000	.000	.000
59	-15.000	15.000	-11.770	.000	.000	.000	.000
60	.000	7.070	.000	20.000	.000	90.000	-45.000
61	-7.070	.000	.000	20.000	.000	90.000	45.000
62	.000	20.000	.000	6.770	.000	.000	-90.000
63	-20.000	.000	.000	6.770	.000	.000	90.000
64	-30.000	.000	.001	360.000	.000	5.000	.000
65	-6.510	6.520	-212.000	212.000	45.000	1.650	1.650
66	-100.000	-60.000	171.460	188.540	90.000	.000	.000
67	.000	40.000	.000	25.000	.000	90.000	-98.540
68	-40.000	.000	.000	25.000	.000	90.000	98.540
69	-56.390	-15.690	170.930	189.070	90.000	.000	-13.500
70	-80.200	-40.100	180.000	193.500	90.000	90.000	-9.070
71	-80.200	-40.100	166.500	180.000	90.000	-90.000	-9.070
72	-2.500	2.500	-6.333	.000	.000	-90.000	.000
73	-12.000	.000	.001	360.000	.000	.000	-45.000
74	-12.000	.000	.001	360.000	.000	.000	45.000
75	.001	180.000	.001	360.000	.000	.000	.000

Table 2-1. OH-58 Helicopter Geometrical Structure Data (Cont'd)

SURFACE NUMBER	HELICOPTER PART DESCRIPTION	SURFACE TYPE	FLIGHT STATION	WATER-LINE	BULKHEAD LINE	ALPHA
76	R. BEND IN TAIL PIPE	SPHERE	-138.000	100.000	-13.500	3.000
77	L. BACK OF TAIL PIPE	CYLINDER	-138.000	100.000	13.500	3.000
78	R. BACK OF TAIL PIPE	CYLINDER	-138.000	100.000	-13.500	3.000
79	L. END OF TAIL PIPE	DISC	-138.000	100.000	13.500	4.000
80	R. END OF TAIL PIPE	DISC	-138.000	100.000	-13.500	4.000

Table 2-1. OH-58 Helicopter Geometrical Structure Data (Cont'd)

SURFACE NUMBER	BETA-MIN	BETA-MAX	GAMMA-MIN	GAMMA-MAX	PSI	THETA	PHI
76	.001	180.000	.001	360.000	.000	.000	.000
77	.000	4.000	.001	360.000	.000	-90.000	.000
78	.000	4.000	.001	360.000	.000	-90.000	.000
79	.000	3.000	.001	360.000	.000	-90.000	.000
80	.000	3.000	.001	360.000	.000	-90.000	.000

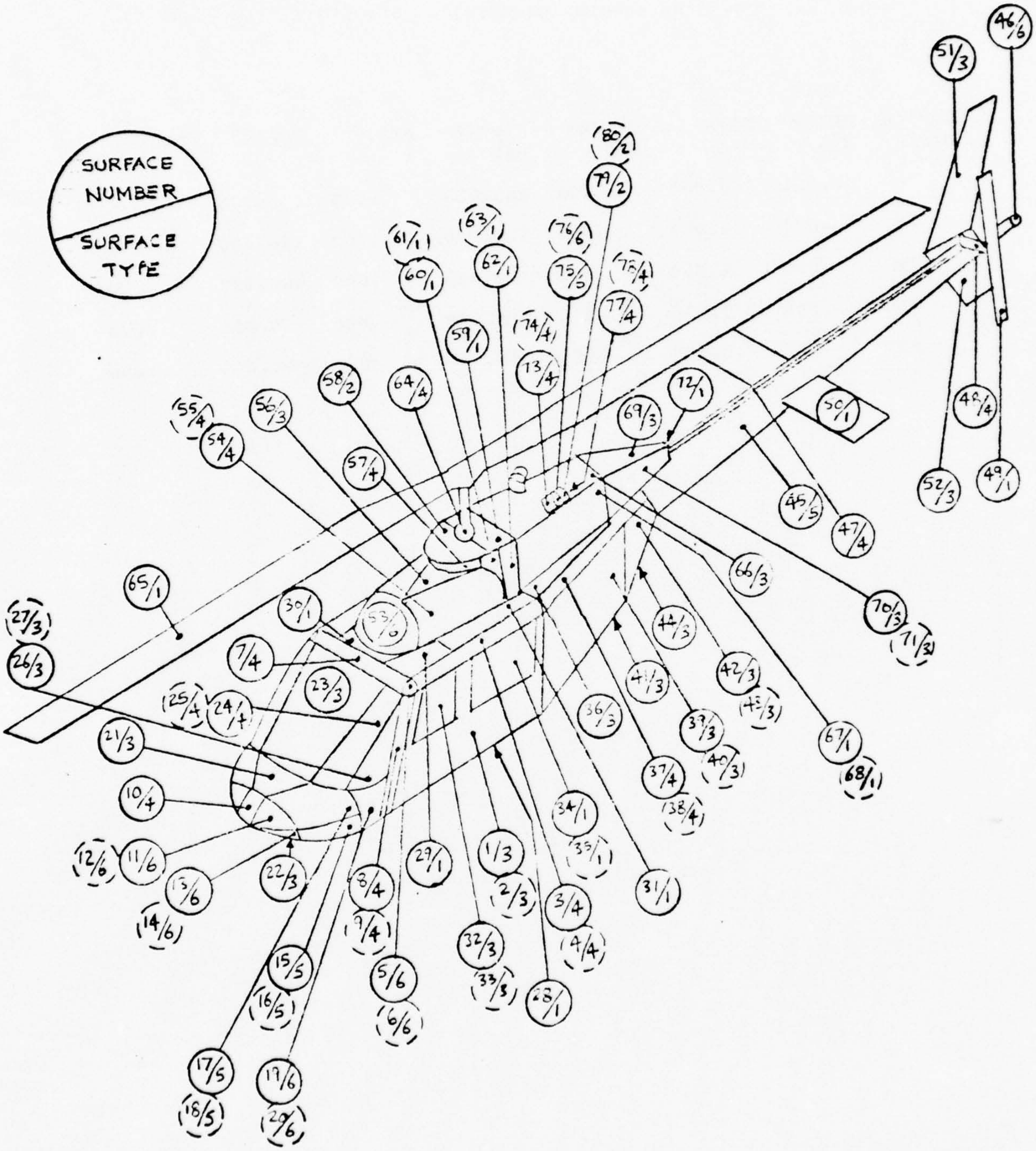
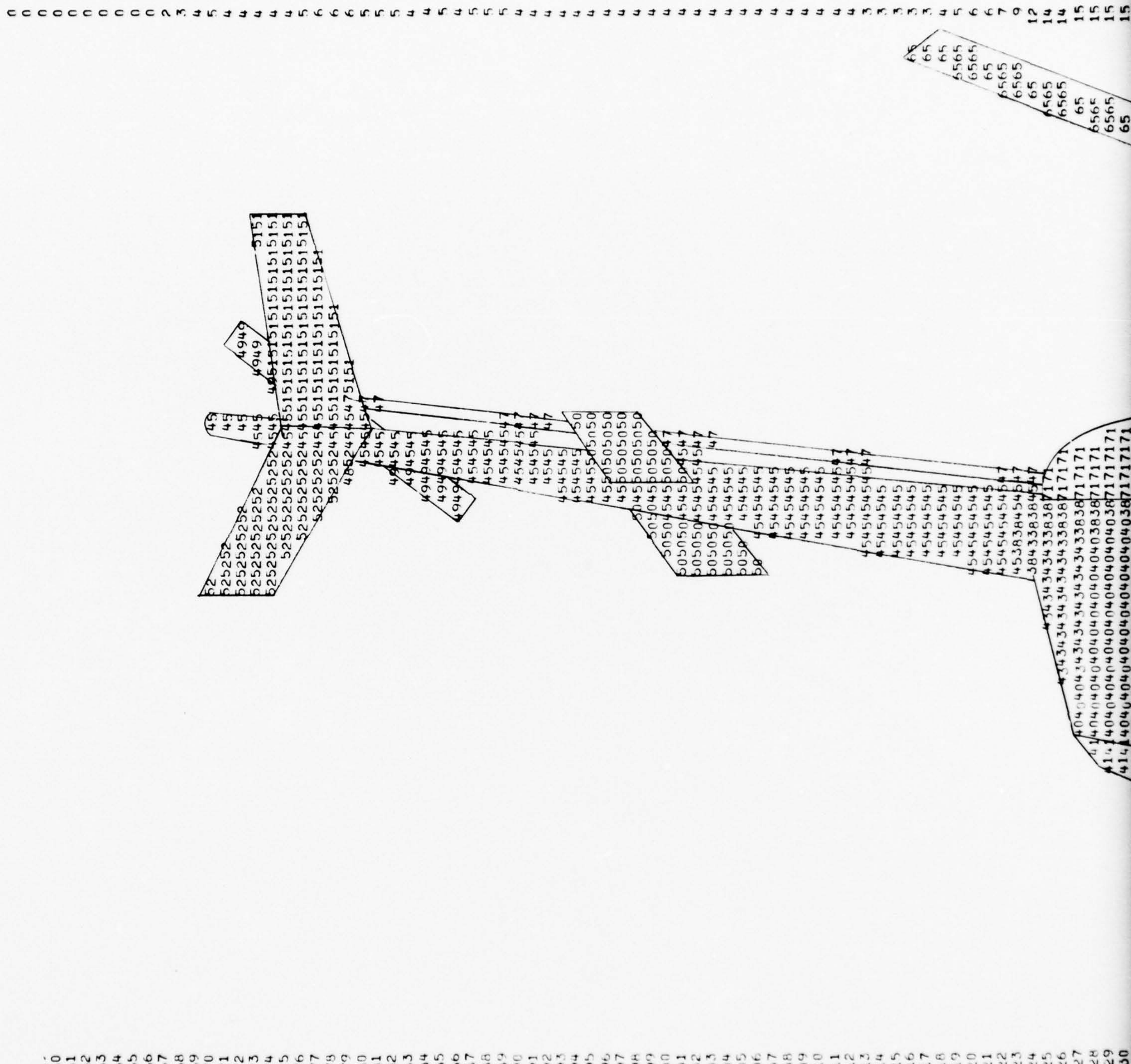


Figure 2-1. OH-58 Surface Locations



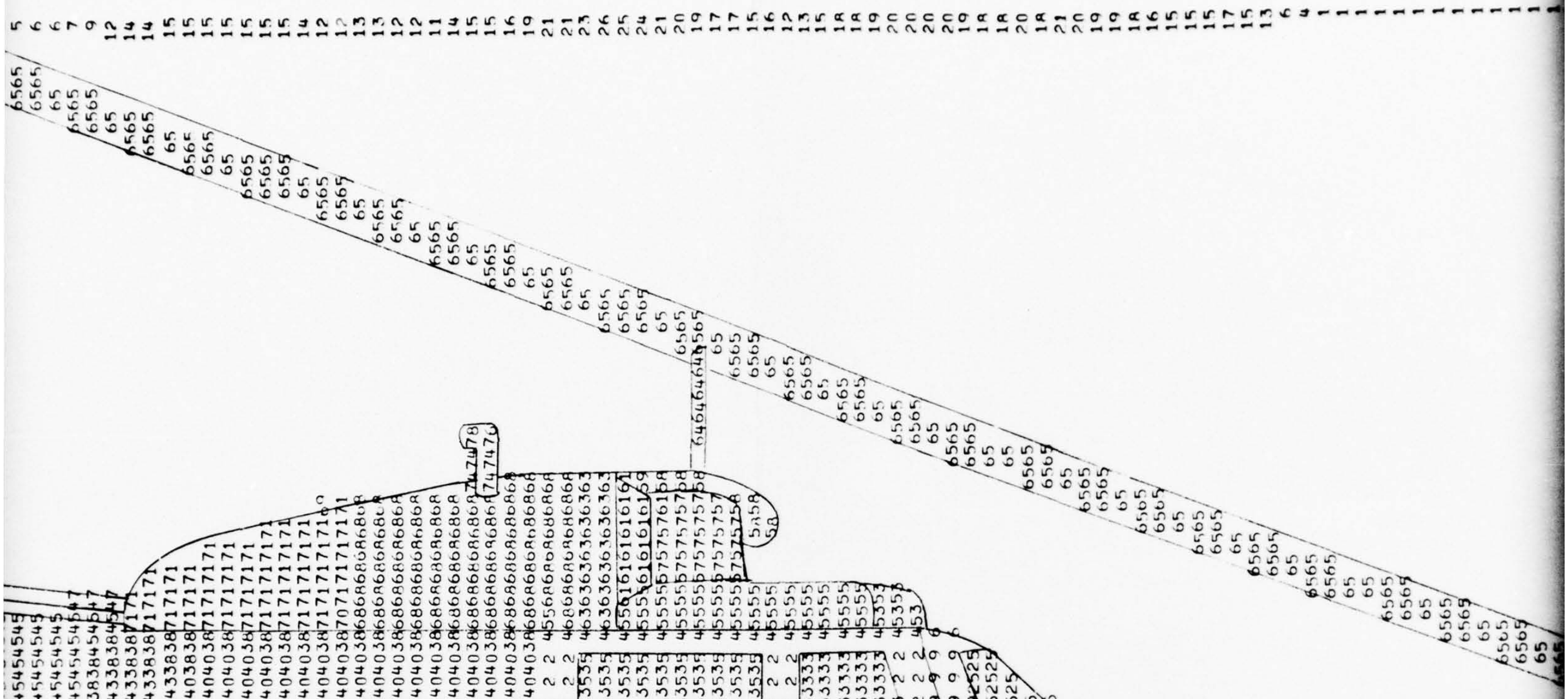


Figure 2-2. (U) OH-58 Printout @ 70° Aspect W
Left Roll

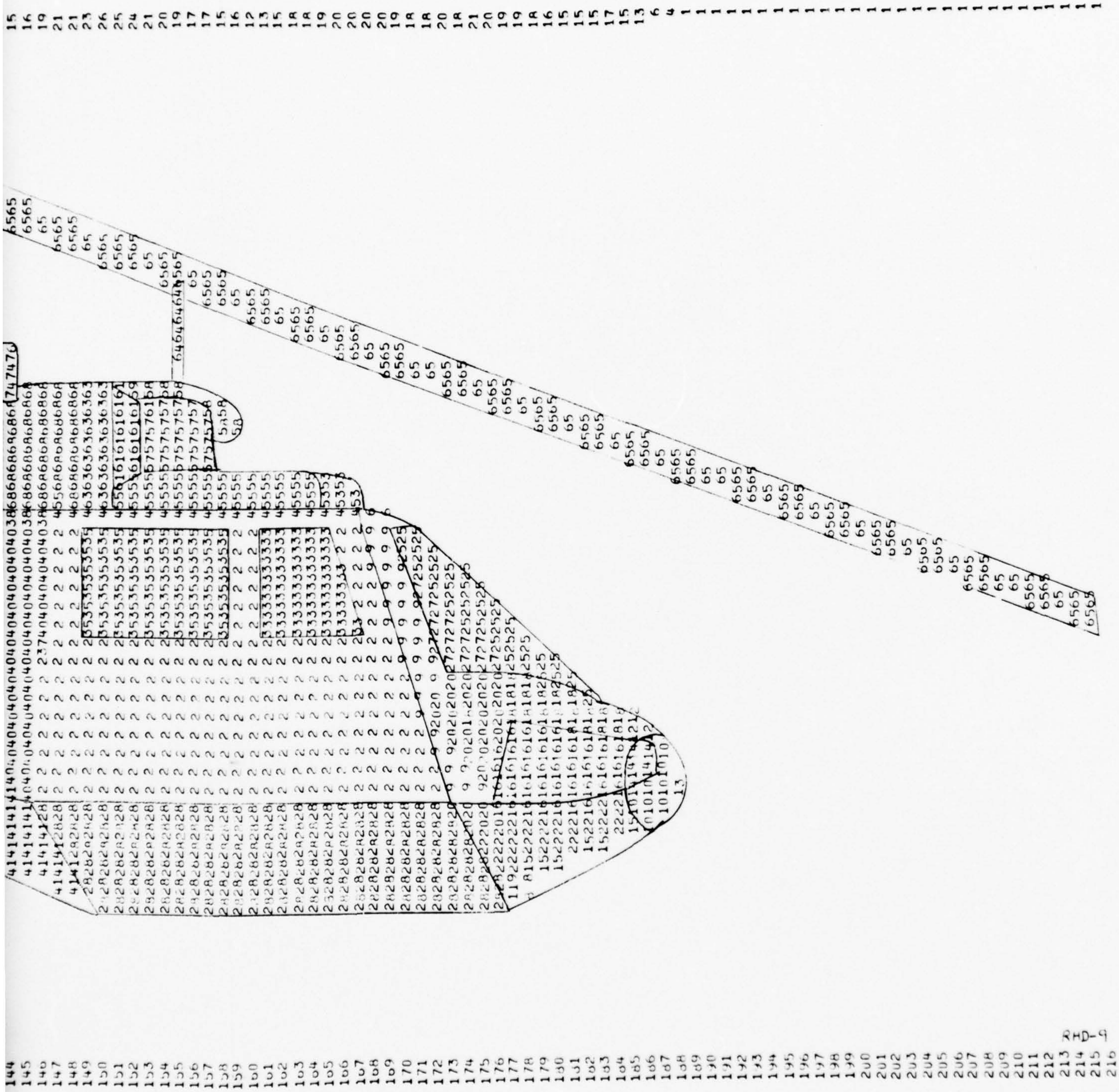


Figure 2-2. (U) OH-58 Printout @ 70° Aspect With 20° Left Roll

3

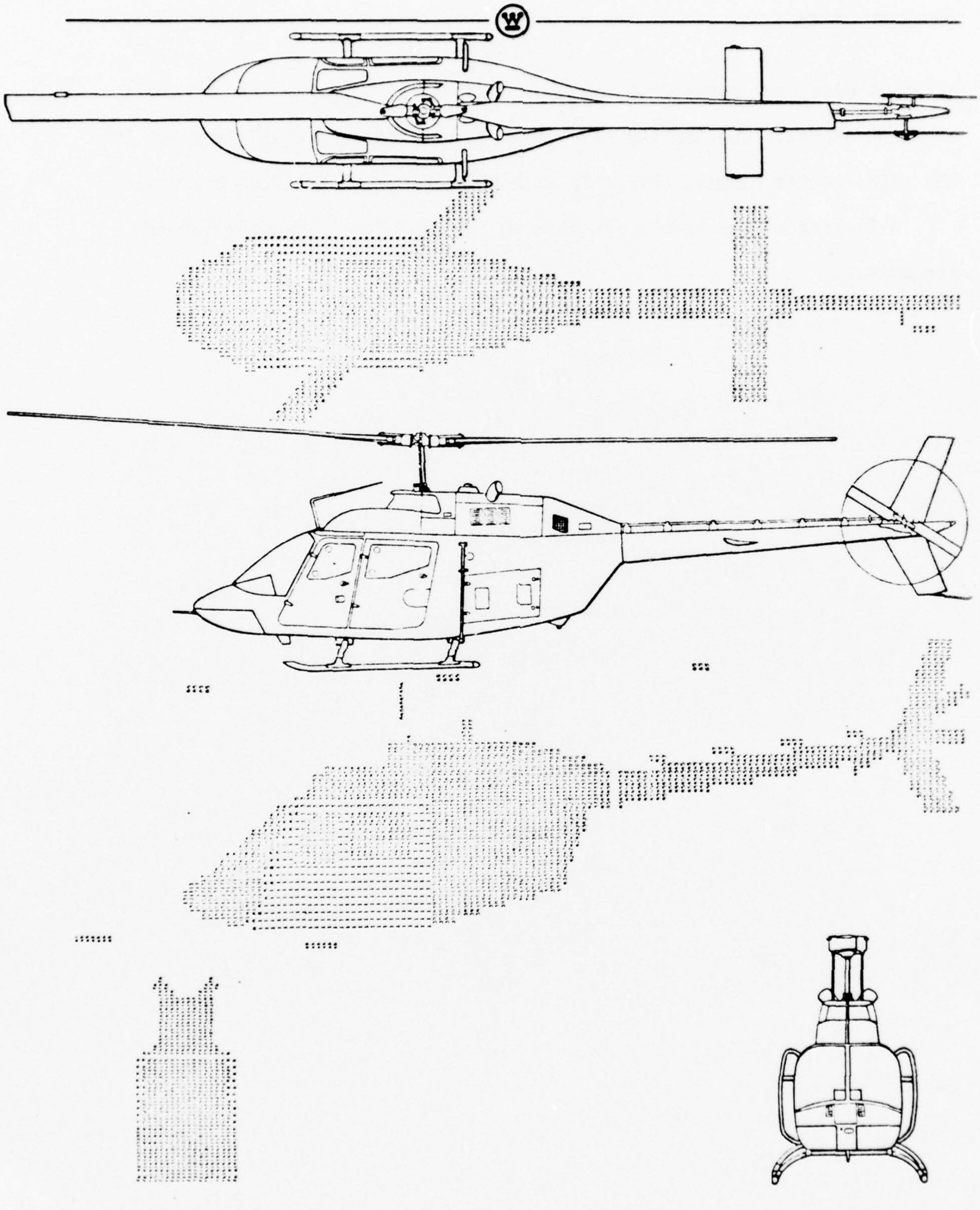


Figure 2-3. (U) OH-58 Silhouette Comparisons

printout have been reduced in size to the scale of a three view drawing from an OH-58 manual. The individual numbers have become too small to read, but the silhousettes compare favorably with those of the three view drawing.

A listing of the body Block Data in the HIDE Model is presented in Appendix A.

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3.0 (U) HELICOPTER OPERATING CHARACTERISTICS AND TURBINE DATA

The Hide Model requires certain data which describes the plume exit from the tailpipe. This data is computed in an off-line program using inputs which describe the helicopter operating characteristics and the turbine. The input data for the off-line program is presented in tabular form in this section. A listing of the off-line program and its block data are presented Appendix B.

3.1 (U) HELICOPTER OPERATING CHARACTERISTICS

The operating characteristics for the OH-58 helicopter are presented in tabular form in Tables 3-1 through 3-3. Table 3-1 presents speed and torque data as a function of pressure altitude for cruise speed. Tables 3-2 and 3-3 present similar data for maximum cruise speed and hover respectively.

The original data from the OH-58 Operator's Manual from which Tables 3-1 to 3-3 were generated are shown in Appendix C. They include specific range curves showing true airspeed and fuel flow as a function of gross weight and pressure altitude, maximum cruise curves showing airspeed limitations as a function of gross weight and air temperature, fuel flow curves showing torque pressure as a function of fuel flow and pressure altitude, and torque and power required to hover curves showing torque pressure and shaft horsepower requirements for hovering as a function of gross weight and density altitude.

3.2 (U) TURBINE DATA

The AH-1G uses one Allison Model T63-A-700 turbine. The data from this engine are presented in tabular form in Tables 3-4 through 3-6. Table 3-4 shows air flow (Wa), fuel flow (Wf) and net thrust (Fg) for various combinations of altitude and shaft horsepower (SHP) settings. Table 3-5 shows Turbine outlet temperature versus shaft horsepower. Table 3-6 presents correction factors for air flow, fuel flow, and net thrust as a function of ambient temperature.

The original data from the Allison manual from which tables 3-4 through 3-6 were generated is shown in Appendix D. They include performance curves for altitudes of 0, 5000, 10,000 15,000 and 20,000 feet, and an ambient temperature correction curve.

Table 3-1. OH-58 Helicopter Speed and Torque Data for Cruise Speed

Pres. Alt. (Ft.)	Gross Weight: 1500 Lbs. Torque Pres. (PSIG)	Gross Weight: 1500 Lbs. Speed (Knots)	Gross Weight: 2000 Lbs. Torque Pres. (PSIG)	Gross Weight: 2000 Lbs. Speed (Knots)
0	53	1035	55	103
2000	50	104	54	104
4000	47	104	53	104
6000	44	104	50	104
8000	43	104	49	104
10000	41	1035	46	104
12000	39.5	103	45	1035
14000	38	103	43	103
16000	38	102	42	103
18000	34	99	40	99
20000	30	94	38	94

Pres. Alt. (Ft.)	Gross Weight: 2500 Lbs. Torque Pres. (PSIG)	Gross Weight: 2500 Lbs. Speed (Knots)	Gross Weight: 3000 Lbs. Torque Pres. (PSIG)	Gross Weight: 3000 Lbs. Speed (Knots)
0	60	103	70	102.5
2000	60	103	65	103
4000	58	103.5	62	103
6000	55	103.5	61	102
8000	55	104	59	97.5
10000	52	104	55	91.5
12000	52	103	51	83
14000	49	98	47	74
16000	47	93	47	64
18000	43	83	45	58
20000	40	73	40	37.5

Table 3-2. OH-58 Helicopter Speed and Torque Data for Maximum Cruise Speed

Pres. Alt. (Ft.)	Gross Weight: 1500 Lbs. Torque Pres. (PSIG)	Gross Weight: 1500 Lbs. Speed (Knots)	Gross Weight: 2000 Lbs. Torque Pres. (PSIG)	Gross Weight: 2000 Lbs. Speed (Knots)
0	53	117	65	115
2000	60	117	64	116
4000	60	120	61	116
6000	58	120	59	115
8000	53	118	57	115
10000	48	115	52	114
12000	45	112	49	112
14000	40	107	47	107
16000	38	103	44	103
18000	34	99	40	99
20000	30	94	38	94
	Gross Weight: 2500 Lbs. Torque Pres. (PSIG)	**Gross Weight: 2500 Lbs.** Speed (Knots)	**Gross Weight: 3000 Lbs.** Torque Pres. (PSIG)	**Gross Weight: 3000 Lbs.** Speed (Knots)
0	71	111.5	69	106.5
2000	68	112.5	68	106.5
4000	64	111	64	104
6000	61	111	61	102
8000	59	109.5	59	97.5
10000	55	106.5	55	91.5
12000	52	103	51	83
14000	49	98	47	74
16000	47	93	47	64
18000	43	83	45	58
20000	40	73	40	37.5

Table 3-3. OH-58 Helicopter Speed and Torque Data for Hover

Pres. Alt. (Ft.)	Gross Weight: 1500 Lbs. Torque Pres. (PSIG)	Gross Weight: 1500 Lbs. Speed (Knots)	Gross Weight: 2000 Lbs. Torque Pres. (PSIG)	Gross Weight: 2000 Lbs. Speed (Knots)
0	30	0	45	0
2000	32	0	46	0
4000	34	0	46	0
6000	35	0	46	0
8000	36	0	47	0
10000	36	0	48	0
12000	38	0	49	0
14000	39	0	50	0
16000	40	0	51	0
18000	40	0	51	0
20000	41	0	52	0

Pres. Alt. (Ft.)	Gross Weight: 2500 Lbs. Torque Pres. (PSIG)	Gross Weight: 2500 Lbs. Speed (Knots)	Gross Weight: 3000 Lbs. Torque Pres. (PSIG)	Gross Weight: 3000 Lbs. Speed (Knots)
0	58	0	73	0
2000	59	0	74	0
4000	60	0	75	0
6000	61	0	77.5	0
8000	62	0	80	0
10000	63	0	82.5	0
12000	64	0	86	0
14000	66	0	90	0
16000	68	0	95	0
18000	72	0	100	0
20000	76	0	110	0

Table 3-4. Engine Parameters at Standard Ambient Temperature

	Altitude: Sea Level			Altitude: 5000 Feet		
SHP	Wa (lb/sec)	Wf (lb/hr)	Fg (lb)	Wa (lb/sec)	Wf (lb/hr)	Fg (lb)
50	2.14	85	7.5	1.9	75	7.5
100	2.43	105	12	2.12	93	12
150	2.65	127.5	16	2.35	117	16
200	2.83	152	21	2.51	144	21
250	3.0	177.5	26	2.66	172.5	26
300	3.14	205.5	32	2.76	207	32

	Altitude: 10,000 Feet			Altitude: 15,000 Feet		
SHP	Wa (lb/sec)	Wf (lb/hr)	Fg (lb)	Wa (lb/sec)	Wf (lb/hr)	Fg (lb)
50	1.45	65	7	1.44	60	7
100	1.88	86	11	1.66	80	11
150	2.08	111	16	1.83	105	16
200	2.23	138	21	1.95	138	21
250	2.33	172.5	26	2.095	171	26
300	2.39	207	32	2.04	204	32

	Altitude: 20,000 Feet		
SHP	Wa (lb/sec)	Wf (lb/hr)	Fg (lb)
50	1.25	50	6
100	1.45	75	11
150	1.6	103.5	16
200	1.65	140	21

Table 3-5. Referred Power Turbine Outlet Total Temperature Versus Referred Shaft Horsepower

$SHP/_{amb}$ θ_{amb}	T_{to}/θ_{amb}*
150	1757
175	1763
200	1770
225	1778
250	1786
275	1794
300	1803

*Note: θ_{amb} = relative temperature ratio = $\frac{T_{amb} \text{ @ altitude } (^{o}F)}{519}$

Table 3.6. Ambient Temperature Correction Factors (100% normal rated power)

Tamb (^{o}R)	$\frac{Wa}{Wa}$	$\frac{Wf}{Wf}$	$\frac{Fg}{amb}$
420	0	0	0
440	0	0	0
460	0	0	0
480	0	0	0
500	0	0	0
520	0	0	0
540	0	0	0
560	0	0	0
580	0	0	0

4.0 (U) OH-58 SIGNATURE

The OH-58 surface data derived and listed in Table 2-1 was put into the HIDE model in the form of "block data" as given in Appendix A. The OH-58 turbine model (listed in Appendix B) was then run off line to derive inputs for the HIDE model. Meteorlogic and operating conditions were selected and the HIDE program executed to generate an OH-58 signature.

The generation of a viable signature represents the completion of the OH-58 model construction. This section describes a typical signature.

4.1 (U) INPUT DATA

The input data that was used to obtain the sample signature is given in Table 4-1.

The identification of the variable names and their units are as follows:

TAIR	= Ambient air temperature, degrees Kelvin
PRESS	= Ambient pressure, millibars
RMIX	= Mixing ratio, gms H_2O/Kgm dry air
VISR	= Visual range, KM
CFRA	= Cloud fraction, tenths
IDAY	= Flag, 1 = night, 2 = day
AZSUN	= Azimuth of sun relative to LOS, degrees
ZESUN	= Zenith of sun, degrees
WINDVL	= Wind velocity, ft/sec
WANGLE	= Compass heading of wind origin, degrees
RGND	= Reflectivity of ground
EGND	= Emissivity of ground
TGND	= Temperature of ground
RCLD	= Reflectivity of cloud
HT	= Helicopter height, KM
PSIH	= Helicopter yaw relative to East, degrees
THETAH	= Helicopter pitch, degrees
PHIH	= Helicopter roll, degrees
SPEEDH	= Helicopter speed, ft/sec
YAWV	= Helicopter velocity vector yaw relative to air frame, degrees
PITCHV	= Helicopter velocity vector pitch relative to air frame, degrees
ROLLV	= Helicopter velocity vector roll relative to air frame, degrees

AMT	= Atmospheric pressure, atmospheres
AIRTMP	= Air temperature at helicopter altitude, deg. Kelvin
FEFF	= Combustion efficiency
FHTOC	= Hydrogen to carbon ratio of fuel
FATOMS	= Number of carbon atoms in fuel molecule
QQ1	= 1 + fuel to air ratio
XTMP	= Exit gas temperature
AIRH20	= Partial pressure of water vapor in air, percent
AIRCO2	= Partial pressure of carbon dioxide in air, percent
XH20	= Partial pressure of water vapor in exhaust gas, percent
XCO2	= Partial pressure of carbon dioxide in exhaust gas percent
AIRCP	= Specific heat of air
EXVEL	= Velocity of exit gas, ft/sec
DOWNSH	= Down wash velocity, ft/sec
DE	= Exit diameter, inches
R	= Range, KM
HO	= Observer Height, KM
HX	= Helicopter position in earth coordinate system (EAST), inches
HY	= Helicopter position in earth coordinate system (NORTH), inches
HZ	= Helicopter position in earth coordinate system (ELEVATION), inches
OX	= Observer position in earth coordinate system (EAST) inches
OY	= Observer position in earth coordinate system (NORTH), inches
OZ	= Observer position in earth coordinate system (ELEVATION), inches
PSIO	= LOS yaw angle, degrees
THETAO	= LOS pitch angle, degrees
PHIO	= LOS roll angle, degrees
TPTMP	= Temperature of tailpipes
TPEMS	= Emissivity of tailpipes
COVER	= Flag, 0 = no suppressor, 1 = suppressor
FOVX	= Observer field of view in azimuth, degrees
FOVY	= Observer field of view in elevation, degrees
ANGX	= Angular resolution in azimuth, degrees
ANGY	= Angular resolution in elevation, degrees
LOW	= Short wave length index
LHI	= Long wave length index
BIASK	= Azimuth displacements of LOS from center of gravity, resolution elements
BIASJ	= Elevation displacement of LOS from center of gravity, resolution elements
CHIT	= Cloud height
ECLD	= Emissivity of cloud
PRD	= Log plot scale factor

TABLE 4-1. (U) INPUT DATA

```
TETHERED OH-58    ASPECT 230

TAIR   =  .28700000E+03  PRESS  =  .10130000E+04  RMIX   =  .27250000E+01
VISR   =  .70000000E+01  CFRA   = 0.                  IDAY   =  .20000000E+01
AZSUN  =  .31900000E+03  ZENSUN=  .66000000E+02  WINDVL=  .10000000E-01
WANGLE= 0.                   RGND   =  .70000000E-01  EGND   =  .93000000E+00
TGND   =  .28700000E+03  RCLD   =  .10000000E+01  HT(1)  =  .12500000E-01
PSIH   =  .61000000E+02  THETAH= -.17000000E+02  PHIH   = -.30000000E+02
SPEEDH= 0.                   YAWV   = 0.                  PITCHV= 0.
ROLLV  = 0.                   ATM    =  .91700000E+00  AIRTMP=  .28700000E+03
FEFF   =  .95000000E+00  FHTOC  =  .20000000E+01  FATOMS=  .70000000E+01
QQ1    =  .10154000E+01  XTMP   =  .38400000E+03  AIRH2O=  .10000000E-02
AIRCO2=  .32000000E-03  XH2O   =  .30000000E-01  XCO2   =  .30000000E-01
XCP    =  .26600000E+00  AIRCP  =  .24000000E+00  EXVEL  =  .25000000E+03
DOWNSH=  .10000000E+02  DE     =  .69550000E+01  R(1)   =  .83900000E-01
HO(1)  =  .10000000E-02  HX     =  .33200000E+04  HY     =  .64000000E+03
HZ     =  .49500000E+03  OX     = 0.                  OY     = 0.
OZ     =  .39370000E+02  PSIO   =  .11000000E+02  THETAO= 0.
PHIO   = 0.                   TPTMP  =  .83000000E+03  TPEMS  =  .40000000E+00
COVER  = 0.                   FOVX   =  .27000000E+01  FOVY   =  .17500000E+01
ANGX   =  .70000000E-01  ANGY   =  .70000000E-01  LOW    =  .20000000E+01
LHI    =  .60000000E+02  BIASK  =  .10000000E+02  BIASJ  =  .80000000E+01
CHIT   =  .10000000E+01  ECLD   =  .10000000E+01  PRD    = $$$$$$$$$$$$
      0.0000        0.0000       39.3701       10.9111       -7.6269       90.0000
   3320.0000      640.0000      492.1260       61.0000      -17.0000      -30.0000
      2.2400        4.4800         .0700         .0700       -8.0000       10.0000
  .98400000E+03 .15400000E-01 .29831199E-01 .33465043E-01
  .25000000E+03 .10000000E+020.                .10000000E+02
  .69550000E+01 .40000000E-01 .99619470E+00 .87155741E-01
  .95560973E+01 .38631945E+02 .22762017E+03
  .44790096E+01 .44393751E+02 .83025696E+02
```

4.2 (U) LOG PLOT SIGNATURE

The signature predicted for these initial conditions is shown in figure 4-1. This figure depicts the spatial intensity distribution of the signature.

The picture consists of a mosaic of 30 by 60 elements. The apparent effective radiance of each element is depicted by a 2 digit number. The first digit represents the characteristic of the logarithym of the radiance multiplied by a scale factor and the second digit the first number of the mantissa.

The value of the radiance is typically less than unity. Therefore it is multiplied by a scale factor PRD. If the product of the radiance times PRD was 267.5, then its logarithm would be log 10 (267.5) = 2.4273, which when rounded off to the first decimal and multiplied by 10, becomes 24. Thus, the two digit value printed out for this surface intercept would be 24.

The advantage of using logarithms is in obtaining a large dynamic range with the fewest digits. For example, the surface radiances in figure 4.1 are in the twenties, while the hot gas values are in the forties. This indicates at a glance that the hot gas is two orders of magnitude more radiant than the surface.

The background radiance values have been suppressed for picture clearity except for the last column and row. This permits determining at a glance what the background level is and if there are any gradients present.

At the bottom of the picture frame are three lines of real numbers which define aspects of the integrated signature in various ways.

The first line gives the components of contrast irradiance which comprise the composite signature. The first number is the total positive contrast irradiance, the second number is the total negative contrast irradiance and

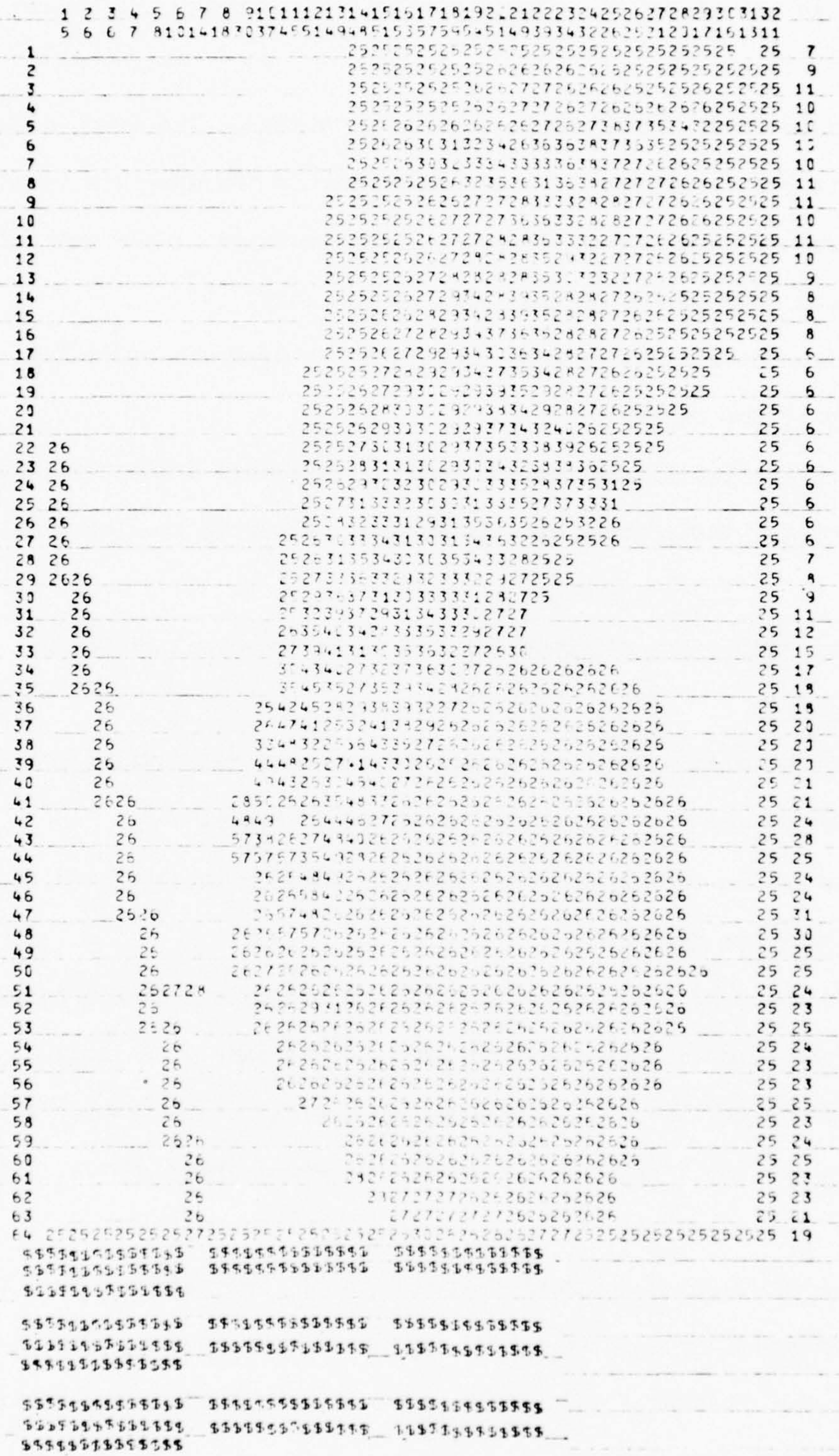


FIGURE 4-1. (U) LOG PLOT SIGNATURE

the third number is the sum of the absolute values of contrast irradiance components.

The second line gives the absolute irradiance values. The first number is the absolute target irradiance, the second number is the absolute irradiance of the background covered by the target, and the third is the contrast irradiance obtained by subtracting the first two numbers.

The third line containing a single number is the apparent effective radiant intensity of the target.

In the above, the irradiance numbers have the standard units, watts/cm^2, the radiant intensity, watts/ster, and the radiant values in the log plot, W/cm^2/ster.

All signature values are weighted for the sensor spectral response.

4.3 (U) SPECTRAL PLOT

The HIDE program also prints out a plot of the spectral radiant intensity of the signature and its composition as shown in figure 4-2.

This plot is in the form of a number pattern wherein the user can connect the numbers and draw the curves.

The identification of the symbols and their priority are listed below. (i.e. If the points on more than one curve fall on the same print location, only one character is printed out overriding the others. Thus, number 1(C) would predominate over all the others, number 3(T) would prempt number 4 (R), etc.)

The vertical coordinate, calibrated from 0 to 10, represents 0 to 100 percent. The horizontal coordinate is calibrated in wavelengths. Each curve is normalized to some reference value which is printed out along the vertical coordinate and specified in Table 4-2.

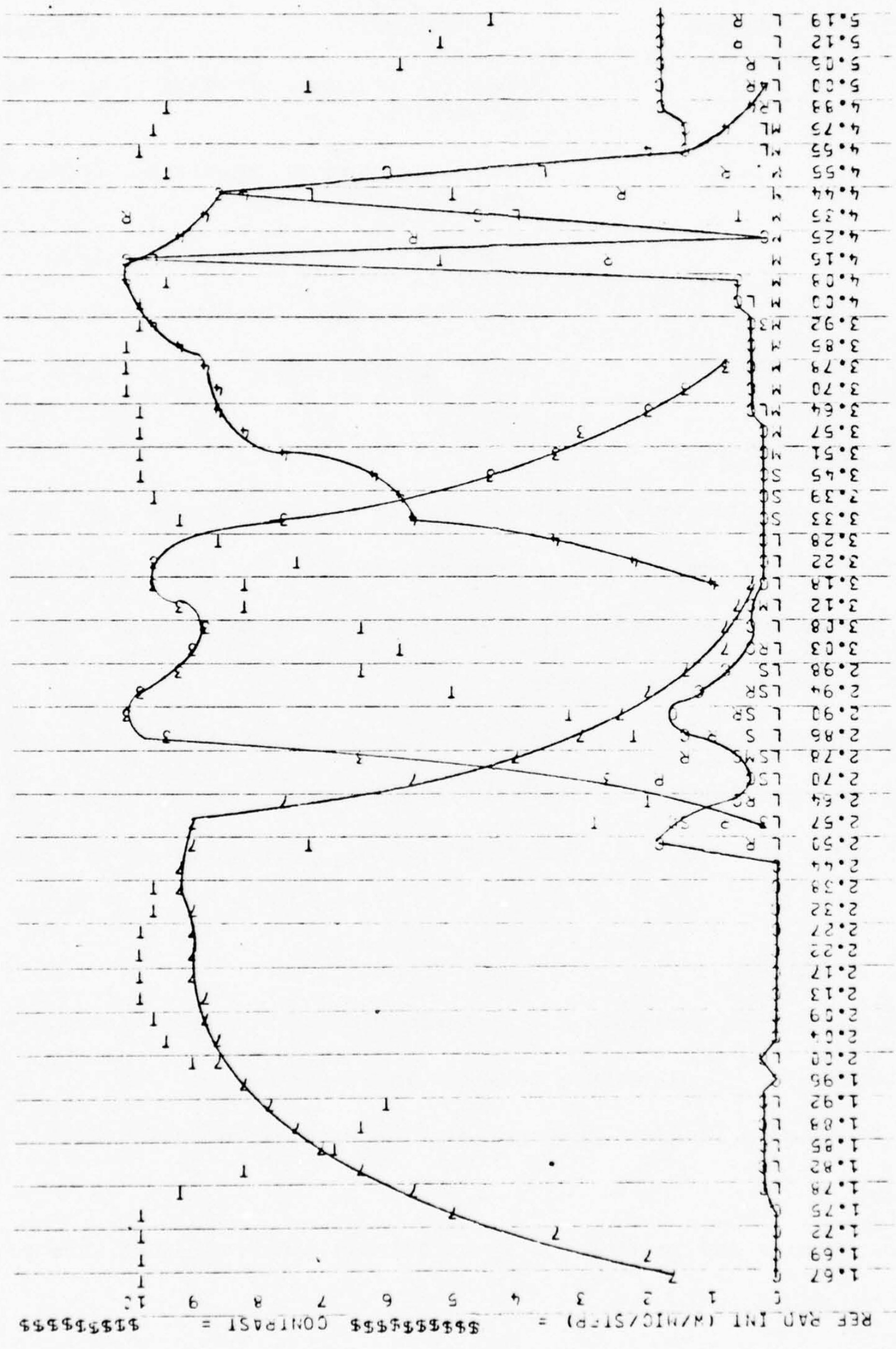


FIGURE 4-2. (U) SPECTRAL PLOT

Table 4-2. (U) Spectral Priorities

PRIORITY	SYMBOL	DEFINITION	REFERENCE
1	C	Spectral radiant intensity at receiver	Contrast
2	S,M,L	Effective apparent spectral radiant intensities	Contrast
3	T	Atmospheric transmission	100%
4	R	Spectral radiant intensity	Rad. Int.
5	3,4,7	Detector responses	100%

4.4 (U) BODY INTERCEPT PLOT

A body intercept plot is also printed out as shown in figure 4-3. This is a mosaic format on a one for one correspondance with the LOG PLOT of the signature. The difference is that the 2 digit numbers given here are the index numbers of the surface elements.

Only body surfaces are shown here, the plume surfaces have been deleted. This plot may be super imposed on the LOG PLOT to investigate the origin of the signature contributions (i.e. tail boom heating, solar glint from windows, etc.).

4.5 (U) GREY SCALE PLOT

The HIDE model also generates a grey scale plot of the spatial distribution of intensity of the signature as shown in figure 4-4.

This is based on a 10 level grey scale using symbols to depict the density levels.

This plot enables one to find hot spots quickly and track them through the BODY and LOG PLOTS.

FIGURE 4-3. (U) BODY INTERCEPT PLOT

4.6 (U) GREY SHADE PLOT

Data from the log plot signature is used in an off line program to generate a grey shade plot as shown in figure 4-5. It depicts the same information as the grey scale plot, but in a way which provides a truer visualization of the grey shade densities. This effect is obtained by use of an overprint process.

4.7 (U) GREY SHADE PHOTO

This photograph, shown in figure 4-6, is a simulation of what an infrared camera would see when looking at the target. It was obtained by processing the digital signature image mosaic. The special intensity distribution values from the log plot signature were fed through a hybrid computer's D/A converter to convert digital values to analog video amplitudes. The video amplitudes were then displayed on a kinescope and photographed. The capability of generating photographs of this type is an inherent feature of the digital mosaic techniques used in the HIDE model.

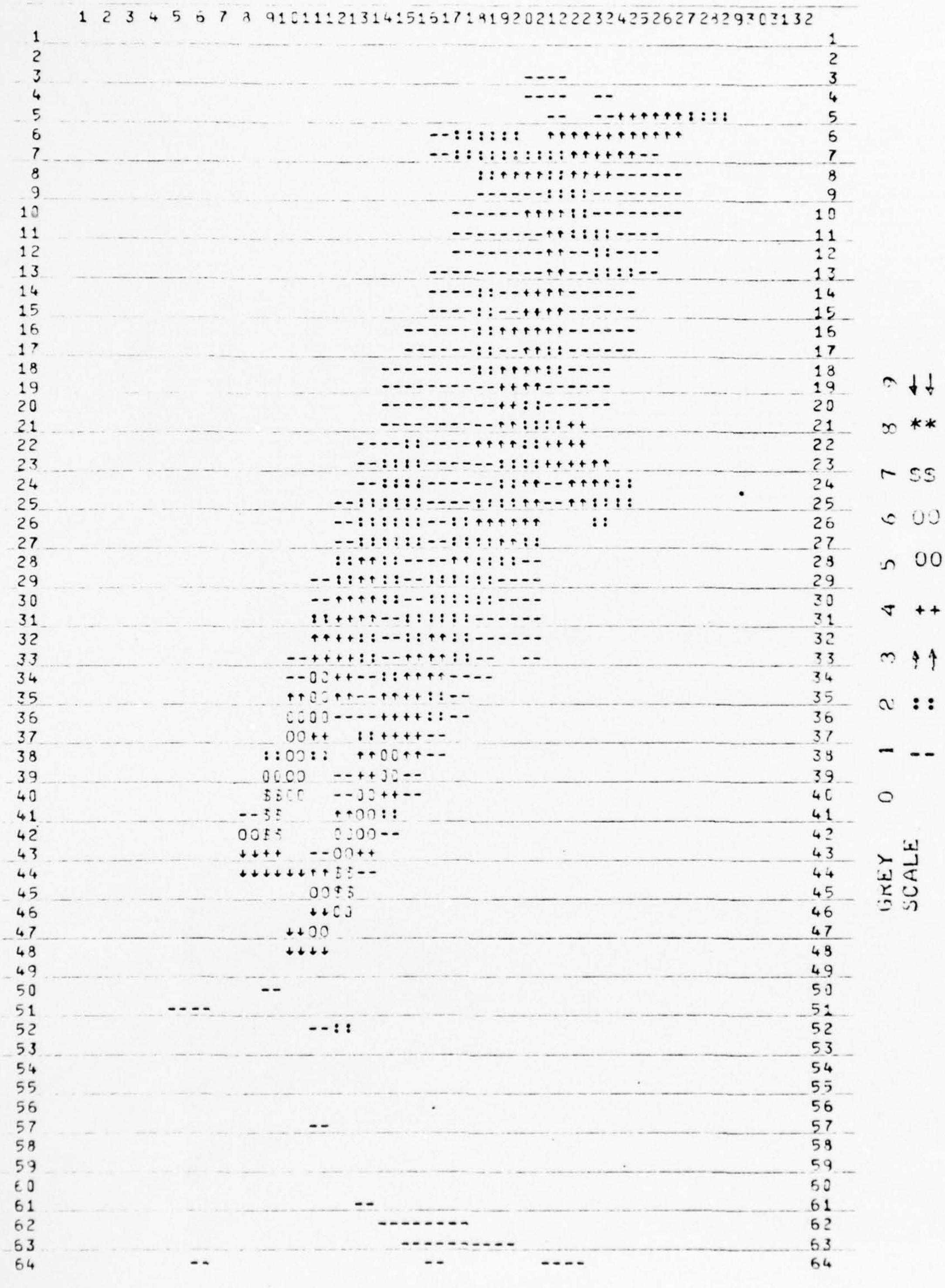


FIGURE 4-4. (U) GREY SCALE PLOT

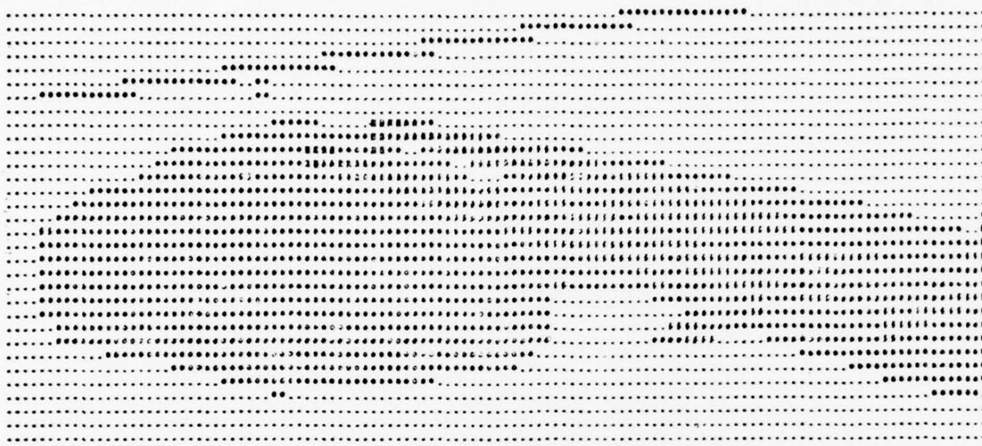


Figure 4-5. (U) Grey Shade Plot

Figure 4-6. (U) Grey Shade Photo

APPENDIX A (U)

BLOCK DATA FOR BODY IN THE HIDE MODEL

```
OHDATA  -- PAGE  1     14.50.56     73/09/25

80 8 64 79
1 -121.000 192.900 26.000 127.900 173.900
.001 25.800 .000 .000 .000 -90.000 3 1
2 -121.000 192.900 -26.000 -173.900 -127.900
154.200 180.000 .000 .000 .000 90.000 3 1
3 -59.200 65.000 19.000 .000 63.000
.001 360.000 7.000 .000 -90.000 .000 4 1
4 -59.200 65.000 -19.000 .000 63.000
.001 360.000 7.000 .000 -90.000 .000 4 1
5 -59.200 65.000 19.000 .001 180.000
.001 360.000 7.000 .000 .000 .000 6 1
6 -59.200 65.000 -19.000 .001 180.000
.001 360.000 7.000 .000 .000 .000 6 1
7 -59.200 65.000 .000 -19.000 19.000
.001 360.000 7.000 .000 .000 90.000 4 1
8 -59.200 65.000 19.000 .000 51.000
180.000 360.000 7.000 .000 154.200 .000 4 1
9 -59.200 65.000 -19.000 .000 51.000
180.000 360.000 7.000 .000 154.200 .000 4 1
10 -8.000 33.000 .000 -7.000 7.000
.001 360.000 7.000 .000 .000 90.000 4 1
11 -8.000 33.000 7.000 .001 90.000
.001 180.000 7.000 90.000 .000 .000 6 1
12 -8.000 33.000 -7.000 .001 90.000
90.000 270.000 7.000 .000 .000 .000 6 1
13 -8.000 33.000 7.000 90.000 180.000
.001 180.000 7.000 90.000 .000 .000 6 3
14 -8.000 33.000 -7.000 90.000 180.000
90.000 270.000 7.000 .000 .000 .000 6 3
15 21.000 33.000 2.000 29.400 58.800
180.000 360.000 13.400 -9.800 -90.000 .000 5 3
16 21.000 33.000 -2.000 29.400 58.800
180.000 360.000 13.400 9.800 -90.000 .000 5 3
17 21.000 33.000 2.000 29.400 58.800
.001 180.000 13.400 -9.800 -90.000 .000 5 1
18 21.000 33.000 -2.000 29.400 58.800
.001 180.000 13.400 9.800 -90.000 .000 5 1
19 -37.000 33.000 12.000 .001 180.000
.001 360.000 14.000 .000 .000 .000 6 1
20 -37.000 33.000 -12.000 .001 180.000
.001 360.000 14.000 .000 .000 .000 6 1
21 32.550 30.200 .000 -71.500 -41.700
170.890 189.110 .000 -90.000 .000 -13.400 3 1
22 32.550 35.900 .000 -71.500 -41.700
170.890 189.110 .000 -90.000 .000 13.400 3 1
23 16.440 17.720 .000 -88.900 -37.000
167.950 192.050 .000 -90.000 .000 -36.500 3 3
24 16.440 10.720 .000 38.250 90.900
.001 360.000 7.000 -12.050 -53.500 .000 4 3
25 16.440 10.720 .000 38.250 90.900
.001 360.000 7.000 12.050 -53.500 .000 4 3
26 -13.640 33.000 15.000 -42.800 .000
144.380 180.000 .000 -102.050 -90.000 .000 3 3
27 -13.640 33.000 -15.000 -42.800 .000
180.000 215.620 .000 -77.950 90.000 .000 3 3
```

OHDATA -- PAGE 2 14.50.56 73/09/25

```
28 -121.000 19.000 .000 -26.000 26.000
.000 84.000 .000 .000 .000 .000 1 1
29 -59.200 72.000 .000 -19.000 19.000
-22.000 .000 .000 .000 .000 .000 1 3
30 -59.200 72.010 .000 -10.000 10.000
-22.000 .000 .000 .000 .000 .000 1 1
31 -121.000 72.000 .000 -19.000 19.000
.000 39.800 .000 .000 .000 .000 1 1
32 -86.280 110.750 26.010 45.750 64.750
9.000 25.800 .000 .000 .000 -90.000 3 3
33 -86.280 110.750 -26.010 -64.750 -45.750
154.200 171.000 .000 .000 .000 90.000 3 3
34 -114.000 65.000 26.010 .000 18.000
.000 30.000 .000 .000 .000 -90.000 1 3
35 -114.000 65.000 -26.010 -18.000 .000
.000 30.000 .000 .000 .000 90.000 1 3
36 -200.600 79.500 .000 -80.000 .000
166.630 193.370 .000 90.000 .000 5.367 3 1
37 -200.600 72.500 .000 .000 84.000
.001 360.000 7.000 13.370 95.367 .000 4 1
38 -200.600 72.500 .000 .000 84.000
.001 360.000 7.000 -13.370 95.367 .000 4 1
39 -468.500 98.800 -56.500 -357.000 -292.200
167.590 174.750 .000 90.000 90.000 -13.370 3 1
40 -468.500 98.800 56.500 -357.000 -292.200
185.250 192.410 .000 90.000 -90.000 -13.370 3 1
41 -230.500 45.450 .000 -112.400 -47.800
166.000 194.000 .000 90.000 .000 13.100 3 1
42 -200.600 72.500 7.000 -17.100 .000
113.750 174.750 .000 90.000 90.000 -13.370 3 1
43 -200.600 72.500 -7.000 -17.100 .000
185.250 246.250 .000 90.000 -90.000 -13.370 3 1
44 -229.550 140.300 .000 -115.900 -73.600
174.550 185.450 .000 90.000 .000 66.900 3 1
45 -475.600 105.400 .000 98.500 300.000
.001 360.000 1.450 .000 96.817 .000 5 1
46 -377.660 93.550 .000 .001 180.000
.001 360.000 2.500 .000 .000 .000 6 1
47 -474.600 108.400 .000 125.000 300.000
.001 360.000 .500 .000 95.367 .000 4 2
48 -352.180 87.180 .000 .000 10.400
.001 360.000 1.000 .000 .000 -90.000 4 2
49 -352.180 96.180 10.400 -2.630 2.640
-31.000 31.000 .000 .000 30.000 -90.000 1 1
50 -270.000 79.800 .000 -38.620 38.620
-18.000 .000 .000 .000 .000 .000 1 1
51 -393.030 197.380 .000 66.300 111.200
16.000 25.000 .000 .000 .000 -90.000 3 1
52 -411.580 -14.200 .000 -106.200 -77.080
146.500 155.000 .000 .000 .000 -90.000 3 1
53 -73.000 72.000 .000 .001 90.000
.001 180.000 11.000 .000 .000 .000 6 1
54 -73.000 72.000 .000 .000 53.100
.001 360.000 11.000 -4.700 -90.000 .000 4 1
55 -73.000 72.000 .000 .000 53.100
```

```
OHDATA  -- PAGE  3    14.50.56    73/09/25

.001 360.000 11.000 4.700 -90.000 .000 4 1
56 -73.000 83.000 .000 .000 49.000
175.300 184.700 .000 -90.000 .000 .000 3 1
57 -109.230 94.000 .000 -15.000 .000
.001 360.000 10.000 .000 .000 .000 4 1
58 -109.230 94.000 .000 .000 15.000
.001 180.000 .000 .000 .000 .000 2 1
59 -109.230 94.000 .000 -15.000 15.000
-11.770 .000 .000 .000 .000 .000 1 1
60 -109.230 94.000 10.000 .000 7.070
.000 20.000 .000 .000 90.000 -45.000 1 1
61 -109.230 94.000 -10.000 -7.070 .000
.000 20.000 .000 .000 90.000 45.000 1 1
62 -121.000 94.000 15.000 .000 20.000
.000 6.770 .000 .000 .000 -90.000 1 1
63 -121.000 94.000 -15.000 -20.000 .000
.000 6.770 .000 .000 .000 90.000 1 1
64 -107.130 118.000 .000 -30.000 .000
.001 360.000 1.250 .000 5.000 .000 4 2
65 -107.130 118.000 .000 -6.510 6.520
-212.000 212.000 .000 45.000 1.650 1.650 1 1
66 -221.000 94.000 .000 -100.000 -60.000
171.460 188.540 .000 90.000 .000 .000 3 1
67 -121.000 94.000 15.000 .000 40.000
.000 25.000 .000 .000 90.000 -98.540 1 1
68 -121.000 94.000 -15.000 -40.000 .000
.000 25.000 .000 .000 90.000 98.540 1 1
69 -215.840 80.840 .000 -56.390 -15.690
170.930 189.070 .000 90.000 .000 -13.500 3 1
70 -240.200 75.000 -4.000 -80.200 -40.100
180.000 193.500 .000 90.000 90.000 -9.070 3 1
71 -240.200 75.000 4.000 -80.200 -40.100
166.500 180.000 .000 90.000 -90.000 -9.070 3 1
72 -200.600 84.500 .000 -2.500 2.500
-6.333 .000 .000 .000 -90.000 .000 1 1
73 -138.000 100.000 13.500 -12.000 .000
.001 360.000 3.000 .000 .000 -45.000 4 2
74 -138.000 100.000 -13.500 -12.000 .000
.001 360.000 3.000 .000 .000 45.000 4 2
75 -138.000 100.000 13.500 .001 180.000
.001 360.000 3.000 .000 .000 .000 6 2
76 -138.000 100.000 -13.500 .001 180.000
.001 360.000 3.000 .000 .000 .000 6 2
77 -138.000 100.000 13.500 .000 4.000
.001 360.000 3.000 .000 -90.000 .000 4 2
78 -138.000 100.000 -13.500 .000 4.000
.001 360.000 3.000 .000 -90.000 .000 4 2
79 -138.000 100.000 13.500 .000 3.000
.001 360.000 4.000 .000 -90.000 .000 2 1
80 -138.000 100.000 -13.500 .000 3.000
.001 360.000 4.000 .000 -90.000 .000 2 1

LENGTH =  161 LINES
```

APPENDIX B (U)

TURBINE MODEL FOR

OH-58

HELICOPTER

LISTING AND BLOCK DATA

```
OHTURB  -- PAGE  1    14.27.43    73/09/25

5 PROGRAM OH58(OUTPUT)
6 PRINT,* OH-58 FLIGHT/TURBINE MODEL OPERATING CONDITIONS *
20 INTEGER THROST,HELOGW,HELOW(8)
25 INTEGER WT,TABLE
30*C  THROST = THROTTLE SETTING  (INTERGER)
40*C    1 = CRUISE SPEED
50*C    2 = MAXIMUM CRUISE SPEED
60*C    3 = HOVER
70 THROST=3
75*C  HELOGW = HELICOPTER GROSS WEIGHT, LBS (INTERGER)
80*C  VALUES = 1500,2000,2500,3000
85 WT=4
88 DATA(HELOW(I),I=1,4)/1500,2000,2500,3000/
89 HELOGW=HELOW(WT)
90*C  A = ALTITUDE, FEET (REAL)
100  A=2000.
110*C TEMP = AMBIENT AIR TEMPERATURE, DEG CENTIGRADE (REAL)
120 TEMP=15.
130 DIMENSION HEIGHT( 13),ALT(4)
180 DIMENSION Q1T1(11),Q2T1(11),Q3T1(11),Q4T1(11)
200 DIMENSION Q1T2(11),Q2T2(11),Q3T2(11),Q4T2(11)
220 DIMENSION Q1T3(11),Q2T3(11),Q3T3(11),Q4T3(11)
260 DIMENSION V1T1(11),V2T1(11),V3T1(11),V4T1(11)
280 DIMENSION V1T2(11),V2T2(11),V3T2(11),V4T2(11)
340 DIMENSION GW(3)
350 DIMENSION VEL(10),PITCH(10)
360 DIMENSION S0(6),W1(6),W2(6),W3(6),W4(6),W5(6)
370 DIMENSION U1(6),U2(6),U3(6),U4(6),U5(6)
380 DIMENSION W9(6),U9(6)
390 DIMENSION F1(6)
400 DIMENSION A0(5),T0(5),D1(5)
410 DIMENSION T2(9),C1(9),C2(9),C3(9)
420 DIMENSION R1(7),R2(7)
430 REAL L1( 5)
440 REAL M1,M2,L
450 DATA (VEL(I4),I4=1,10)/0.,10.,20.,30.,40.,50.,60.,70.,80.,90./
460 DATA (PITCH(I4),I4=1,10)/.45,.20,-.25,-.90,-1.7,-2.5,-3.7,-5.05,
470+-6.35,-8./
540 DATA (S0(I1),I1=1,6)/50.,100.,150.,200.,250.,300./
550 DATA (W1(I1),I1=1,6)/2.14,2.43,2.65,2.83,3.0,3.14/
560 DATA (W2(I1),I1=1,6)/1.9,2.12,2.35,2.51,2.66,2.76/
570 DATA (W3(I1),I1=1,6)/1.45,1.88,2.08,2.23,2.33,2.39/
580 DATA (W4(I1),I1=1,6)/1.44,1.66,1.83,1.95,2.095,2.04/
590 DATA (W5(I1),I1=1,4)/1.25,1.45,1.6,1.65/
600 DATA (U1(I2),I2=1,6)/85.,105.,127.5,152.,177.5,205.5/
610 DATA (U2(I2),I2=1,6)/75.,93.,117.,144.,172.5,207./
620 DATA (U3(I2),I2=1,6)/65.,86.,111.,138.,172.5,207./
630 DATA (U4(I2),I2=1,6)/60.,80.,105.,138.,171.,204./
640 DATA (U5(I2),I2=1,4)/50.,75.,103.5,140./
650 DATA (F1(I3),I3=1,6)/7.5,12.,16.,21.,26.,32./
660 DATA (A0(I4),I4=1,5)/0.,5000.,10000.,15000.,20000./
670 DATA (T0(I4),I4=1,5)/519.,501.,483.,465.,447./
680 DATA (D1(I4),I4=1,5)/.00238,.00205,.001755,.001493,.0012681 /
690 DATA (L1(I4),I4=1,5)/1.000,.832,.688,.564,.460/
700 DATA (T2(I5),I5=1,9)/420.,440.,460.,480.,500.,520.,540.,560.,580./
```

```
OHTURB  -- PAGE  2    14.27.43    73/09/25

710 DATA (C1(I5),I5=1,9)/0.,0.,0.,0.,0.,0.,0.,0.,0./
720 DATA (C2(I5),I5=1,9)/0.,0.,0.,0.,0.,0.,0.,0.,0./
730 DATA (C3(I5),I5=1,9)/0.,0.,0.,0.,0.,0.,0.,0.,0./
740 DATA (R1(I6),I6=1,7)/150.,175.,200.,225.,250.,275.,300./
750 DATA (R2(I6),I6=1,7)/1757.,1763.,1770.,1778.,1786.,1794.,1803./
760 DATA G/32.2/
770 DATA H/.24/
780 DATA E/778./
790 DATA(HEIGHT(K1),K1=1,11)/0.,2000.,4000.,6000.,8000.,10000.,
800+12000.,14000.,16000.,18000.,20000./
860 DATA(Q1T2(K1),K1=1,11)/63.,60.,60.,58.,53.,48.,45.,40.,38.,34.,30./
880 DATA(V2T2(K1),K1=1,11)/115.,116.,116.,115.,115.,114.,
890+112.,107.,103.,99.,94./
900 DATA(Q2T2(K1),K1=1,11)/65.,64.,61.,59.,57.,52.,49.,47.,44.,40.,38./
920 DATA(V3T2(K1),K1=1,11)/111.5,112.5,111.,111.,109.5,106.5,
930+103.,98.,93.,83.,73./
940 DATA(Q3T2(K1),K1=1,11)/71.,68.,64.,61.,59.,55.,52.,49.,47.,43.,40./
960 DATA(V4T2(K1),K1=1,11)/106.5,106.5,104.,102.,97.5,91.5,
965+83.,74.,64.,58.,37.5/
970 DATA(Q4T2(K1),K1=1,11)/69.,68.,64.,61.,59.,55.,51.,47.,47.,45.,40./
1250 DATA (V1T1(K1),K1=1,11)/103.5,104.,104.,104.,104.,103.5,
1260+103.,103.,102.,99.,94./
1270 DATA(Q1T1(K1),K1=1,11)/53.,50.,47.,44.,43.,41.,39.5,38.,38.,34.,
1280+30./
1290 DATA(V2T1(K1),K1=1,11)/103.,104.,104.,104.,104.,104.,
1300+103.4,103.,103.,99.,94./
1310 DATA(Q2T1(K1),K1=1,11)/55.,54.,53.,50.,49.,46.,45.,43.,42.,40.,38/
1330 DATA(V3T1(K1),K1=1,11)/103.,103.,103.5,103.5,104.,104.,
1340+103.,98.,93.,83.,73./
1350 DATA(Q3T1(K1),K1=1,11)/60.,60.,58.,55.,55.,52.,52.,49.,47.,43.,40/
1370 DATA(V4T1(K1),K1=1,11)/102.5,103.,103.,102.,97.5,91.5,
1375+83.,74.,64.,58.,37.5/
1380 DATA(Q4T1(K1),K1=1,11)/70.,65.,62.,61.,59.,55.,47.,47.,45.,40./
1470 DATA(V1T2(K1),K1=1,11)/117.,117.,120.,120.,118.,115.,
1480+112.,107.,103.,99.,94./
1510 DATA(Q1T3(K1),K1=1,11)/30.,32.,34.,35.,36.,37.,38.,39.,40.,40.,41/
1550 DATA(Q2T3(K1),K1=1,11)/45.,46.,46.,46.,47.,48.,49.,50.,51.,51.,52/
1590 DATA(Q3T3(K1),K1=1,11)/58.,59.,60.,61.,62.,63.,64.,66.,68.,72.,76/
1620 DATA(Q4T3(K1),K1=1,11)/73.,74.,75.,77.5,80.,82.5,
1630+86.,90.,95.,100.,110./
1701   DATA PI/3.1415926535/
1702   DATA DTR/0.0174532925/
1703   DATA CHORD/1.0859/
1704   DATA BLADES/2./
1705   DATA RADIUS/17.667/
1706   DATA ROTSPD/5.9/
1707   DATA DRAG/0.0083/
1708   DATA PWREFF/0.85/
1709   DATA TILT/0./
1710 T = 15. - 2.*A/1000.
1720 D=TEMP-T
1730 B=-(D+25.)*D*(D-10.)*(D-30.)*(D-40.)/15./40./50./70./80.
1740 B=B*3.28571
1750 B=B+(D+40.)*D*(D-10.)*(D-30.)*(D-40.)/15./25./35./55./65.*2.
1760 B=B-(D+40.)*(D+25.)*D*(D-30.)*(D-40.)/50./35./10./20./30.
```

OHTURB -- PAGE 3 14.27.43 73/09/25

```
B=B+(D+40.)*(D+25.)*D*(D-10.)*(D-40.)/70./55./30./20./10.*2.71429
DELP=B-(D+40.)*(D+25.)*D*(D-10.)*(D-30.)/80./65./40./30./10.*3.571
A = A + 1000.*DELP
T = TEMP*9./5.+492.
TABLE = (THRUST-1 )*4  + WT
GO TO (1,2,3,4,5,6,7,8,9,10,11,12),TABLE
1 CALL CONFRA(11,HEIGHT,V1T1,A,V)
CALL CONFRA(11,HEIGHT,Q1T1,A,Q)
GO TO 199
2 CALL CONFRA(11,HEIGHT,V2T1,A,V)
CALL CONFRA(11,HEIGHT,Q2T1,A,Q)
GO TO 199
3 CALL CONFRA(11,HEIGHT,V3T1,A,V)
CALL CONFRA(11,HEIGHT,Q3T1,A,Q)
GO TO 199
4 CALL CONFRA(11,HEIGHT,V4T1,A,V)
CALL CONFRA(11,HEIGHT,Q4T1,A,Q)
GO TO 199
5 CALL CONFRA(11,HEIGHT,V1T2,A,V)
CALL CONFRA(11,HEIGHT,Q1T2,A,Q)
GO TO 199
6 CALL CONFRA(11,HEIGHT,V2T2,A,V)
CALL CONFRA(11,HEIGHT,Q2T2,A,Q)
GO TO 199
7 CALL CONFRA(11,HEIGHT,V3T2,A,V)
CALL CONFRA(11,HEIGHT,Q3T2,A,Q)
GO TO 199
8 CALL CONFRA(11,HEIGHT,V4T2,A,V)
CALL CONFRA(11,HEIGHT,Q4T2,A,Q)
GO TO 199
9 V=0.
CALL CONFRA(11,HEIGHT,Q1T3,A,Q)
GO TO 199
10 V=0.
CALL CONFRA(11,HEIGHT,Q2T3,A,Q)
GO TO 199
11 V=0.
CALL CONFRA(11,HEIGHT,Q3T3,A,Q)
GO TO 199
12 V=0.
CALL CONFRA(11,HEIGHT,Q4T3,A,Q)
199 CONTINUE
A = A - 1000.*DELP
OTP = Q
TC= 5./9.*(T-492.)
S=(100./29.1)*OTP
CALL CONFRA(10,VEL,PITCH,V,BETA)
 ALPHA = (BETA - TILT)*DTR
VO=V*1.67
HEL = HELOGW
CALL CONFRA(5,AO,TO,A,T1)
CALL CONFRA(5,AO,D1,A,D)
CALL CONFRA(5,AO,L1,A,L)
 SIGMAE = CHORD*BLADES/(PI*RADIUS)
 SPDRTO = VO*COS(ALPHA)/(2.*PI*ROTSPD*RADIUS)
```

```
 PWREQ = PI**4*D*ROTSPD**3*RADIUS**5*DRAG
 PWREQ = PWREQ*SIGMAE*(1.+SPDRTO**2)
 PWRAVL = PWREFF*550.*S
 VIN = (PWRAVL - PWREQ)*COS(ALPHA)/HEL + VO*SIN(ALPHA)
IF (VIN.LT.0.) VIN=.01
CALL CONFRA(6,SO,W1,S,W9(1))
CALL CONFRA(6,SO,W2,S,W9(2))
CALL CONFRA(6,SO,W3,S,W9(3))
CALL CONFRA(6,SO,W4,S,W9(4))
CALL CONFRA(4,SO,W5,S,W9(5))
CALL CONFRA(6,SO,U1,S,U9(1))
CALL CONFRA(6,SO,U2,S,U9(2))
CALL CONFRA(6,SO,U3,S,U9(3))
CALL CONFRA(6,SO,U4,S,U9(4))
CALL CONFRA(4,SO,U5,S,U9(5))
CALL CONFRA(6,SO,F1,S,F9)
CALL CONFRA(5,AO,W9,A,W8)
CALL CONFRA(5,AO,U9,A,U8)
F8=F9
D2=D*T1/T
M1=T1/519.
M2=SQRT(M1)
CALL CONFRA(9,T2,C1,T1,C4)
CALL CONFRA(9,T2,C2,T1,C5)
CALL CONFRA(9,T2,C3,T1,C6)
CALL CONFRA(9,T2,C1,T,C7)
CALL CONFRA(9,T2,C2,T,C8)
CALL CONFRA(9,T2,C3,T,C9)
R3=S/(L*M2)
CALL CONFRA(6,R1,R2,R3,R4)
R5=R4*T/519.
W6 = W8*(1.+(C7-C4)/(1.+C4))
U6 = U8*(1.+(C8-C5)/(1.+C5))
F5=F8-(W8*VO)/G
F6 = F5+(L*C9-W8*(1.+C7)*VO/G)-(L*C6-W8*(1.+C4)*VO/G)
Q1=1.+U6/(W6*3600.)
V7=(G*F6/W6+2.*VO)/Q1
T7 = R5-V7**2/(2.*G*H*E)
A7=(W6*T7*Q1)/(C*D2*T*V7)
A7=A7/2.
D7=24.*SQRT(A7/3.1416)
PRINT 222, A, T, THROST,HELOGW
222 FORMAT(//*ALTITUDE(FT) = *,F12.4/
+* AMBIENT TEMPERATURE (R) = *,F12.4/
+* THROTTLE SETTING = *,I4/
+* GROSS WEIGHT (LBS) = *,I10)
PRINT 225, V, S, V7, T7, D7, Q1, BETA, VIN
225 FORMAT(//* VELOCITY (KNOTS) IAS = *,F12.4/
+* SHP = *,F12.4/
+* EXIT VELOSITY (FT/SEC) = *,F12.4/
+* EXIT TEMPERATURE (R) = *,F12.4/
+* EXIT DIAMETER (INCHES) = *,F12.4/
+* 1 + FUEL/AIR RATIO = *,F12.4/
+* HELICOPTER PITCH (DEG) = *,F12.4/
+* DOWN WASH VELOSITY (FT/SEC) = *,F12.4)
```

```
END
*C   PHILLIPS INTERPOLATION RUTINE
*C
*C
SUBROUTINE CONFRA(N,X,Y,XI,YI)
DIMENSION X(1),Y(1)
IF(XI.LT.X(1))GO TO 100
IF(XI.GT.X(N))GO TO 110
DO 10 I=2,N
II=I
IF(XI.LT.X(I))GO TO 20
10 CONTINUE
20 I2=II+1
I1=II
I0=II-1
NN=N+1
IF(I2.NE.NN)GO TO 40
I2=II
I1=II-1
I0=II-2
40 A1=(XI-X(I1))*(XI-X(I2))/((X(I0)-X(I1))*(X(I0)-X(I2)))
A2=(XI-X(I0))*(XI-X(I2))/((X(I1)-X(I0))*(X(I1)-X(I2)))
A3=(XI-X(I0))*(XI-X(I1))/((X(I2)-X(I0))*(X(I2)-X(I1)))
YI=A1*Y(I0)+A2*Y(I1)+A3*Y(I2)
GO TO 1000
100 I2=1
I1=2
I0=3
GO TO 120
110 I2=N
I1=N-1
I0=N-2
120 A=(X(I0)-X(I2))
Y2P=(Y(I2)-Y(I1))/(X(I2)-X(I1))
A=A*A
B=(X(I1)-X(I2))
B=B*B
C=X(I0)-X(I1)
DEN=A*B*C
D1=(Y(I0)-Y2P*(X(I0)-X(I2))-Y(I2))*B
D2=(Y(I1)-Y2P*(X(I1)-X(I2))-Y(I2))*A
AA=(D1-D2)/DEN
D1=D1*B
D2=D2*A
BB=(D2-D1)/DEN
A=XI-X(I2)
A=A*A*A
B=XI-X(I2)
B=B*B
YI=AA*A+BB*B+Y2P*(XI-X(I2))+Y(I2)
1000 GO TO 1500
*C  TO PRINT OUT INTERPOLATIONS CHANGE STATMENT 1000 TO CONTINUE
PRINT 1010,XI,YI
PRINT 1020,(X(I),I=1,N)
PRINT 1020,(Y(I),I=1,N)
```

```
OHTURB  -- PAGE  6     14.27.43     73/09/25

03900 1010 FORMAT(//*X=*F10.4,*Y=*F10.4)
03910 1020 FORMAT(9F8.3)
03920 1500 CONTINUE
03930 RETURN
03940 END

LENGTH =  280 LINES
```

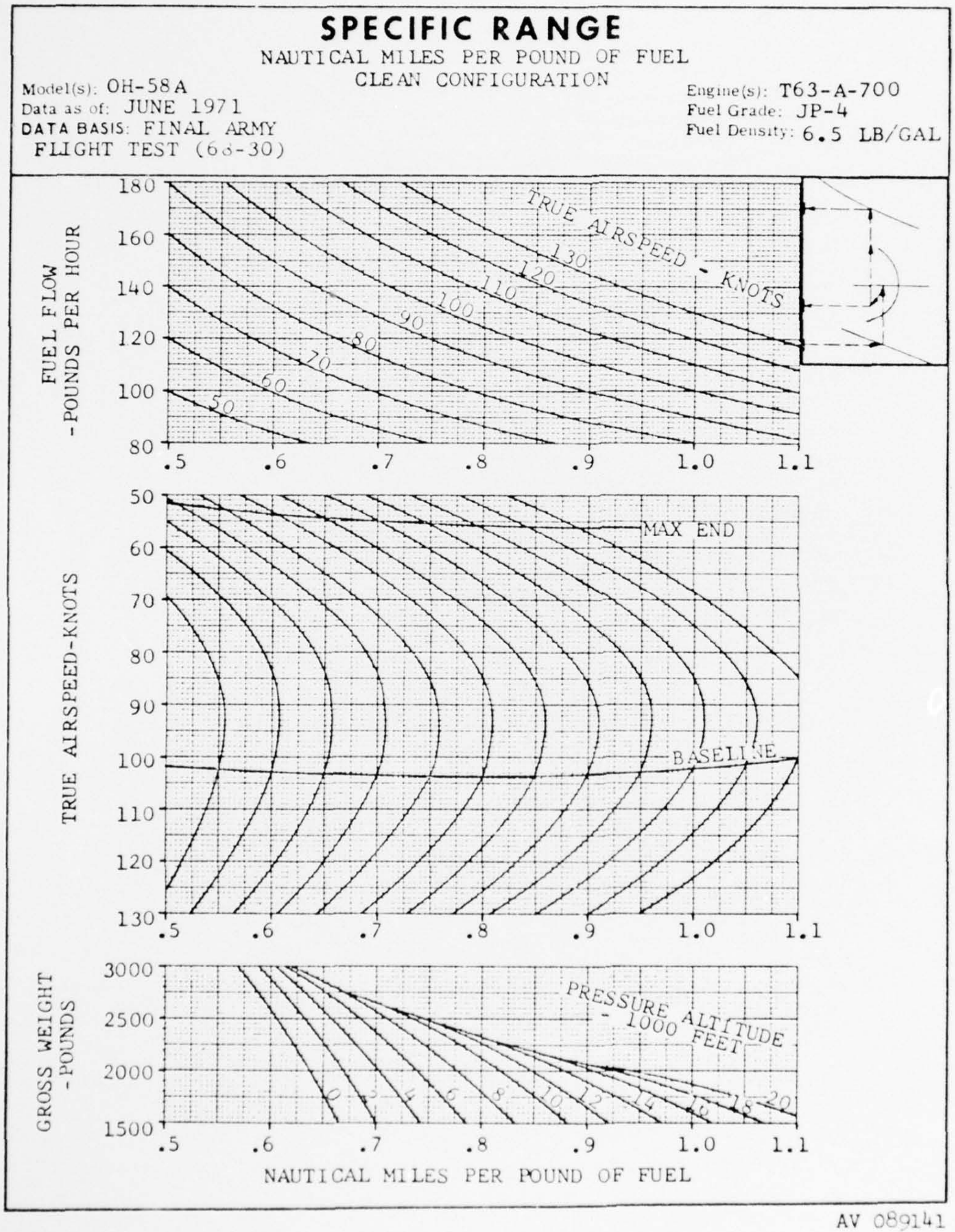
APPENDIX C (U)

SELECTED DATA

FROM THE

OH-58

OPERATOR's MANUAL



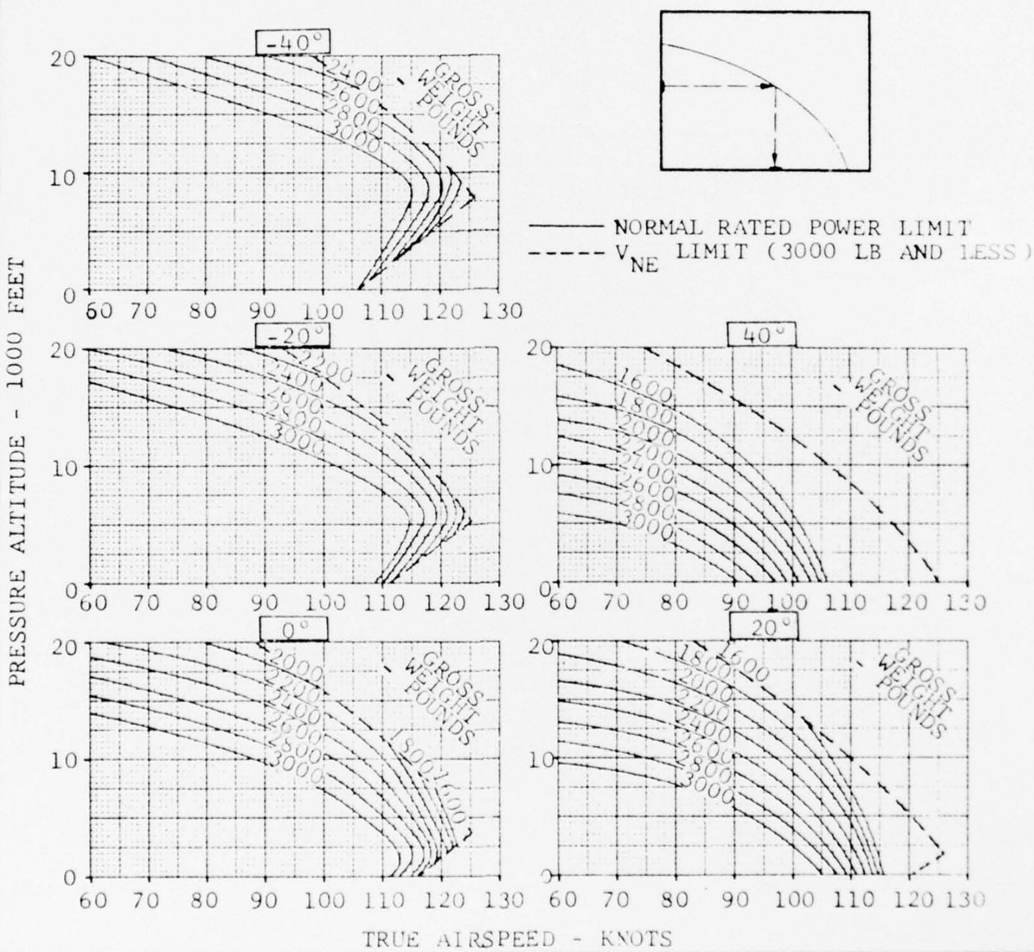
Specific range — clean

MAXIMUM CRUISE SPEED

CLEAN CONFIGURATION

Model(s): OH-58A
Data as of: JUNE 1971
DATA BASIS: FINAL ARMY FLIGHT TEST (68-30)

Engine(s): T63-A-700
Fuel Grade: JP-4
Fuel Density: 6.5 LB/GAL



AV 089145

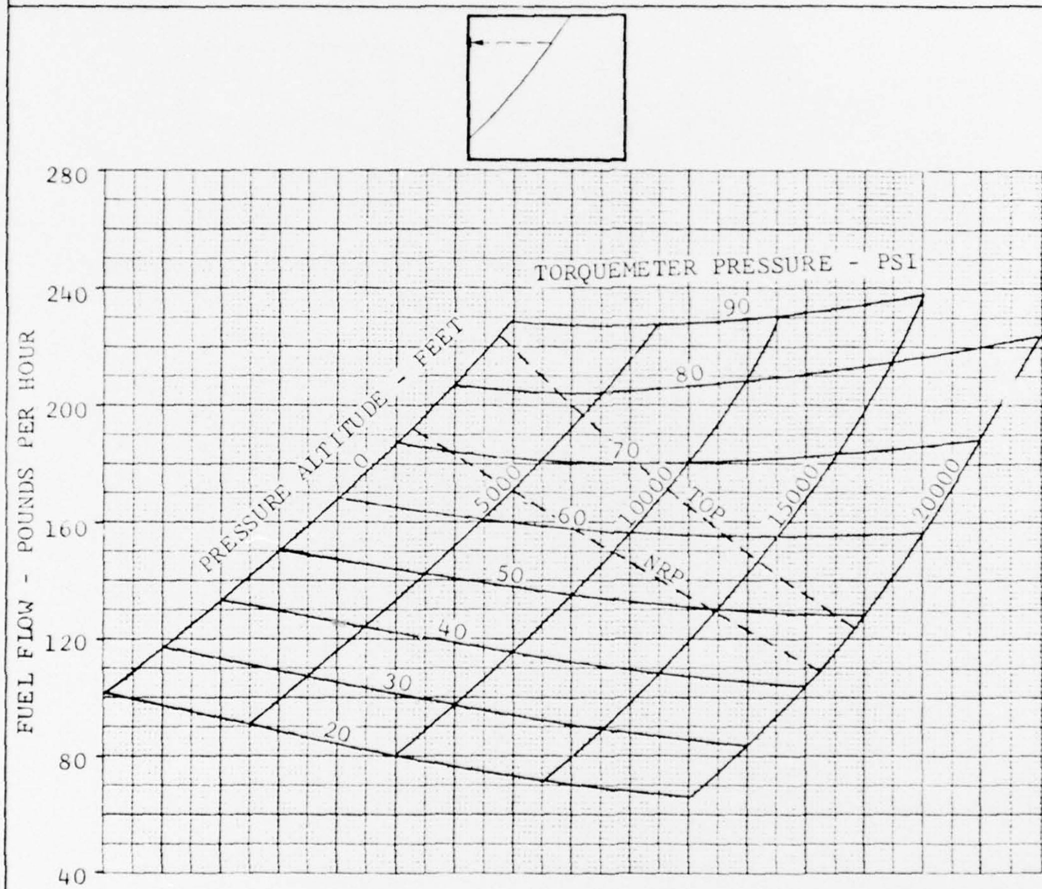
Maximum cruise speed — clear

FUEL FLOW

Model(s): OH-58A
Data as of: JUNE 1971
DATA BASIS: FINAL ARMY FLIGHT TEST (68-30)

STANDARD DAY
6180 RPM
WITH PARTICLE SEPARATOR

Engine(s): T63-A-700
Fuel Grade: JP-4
Fuel Density: 6.5 LB/GAL



AV 089124

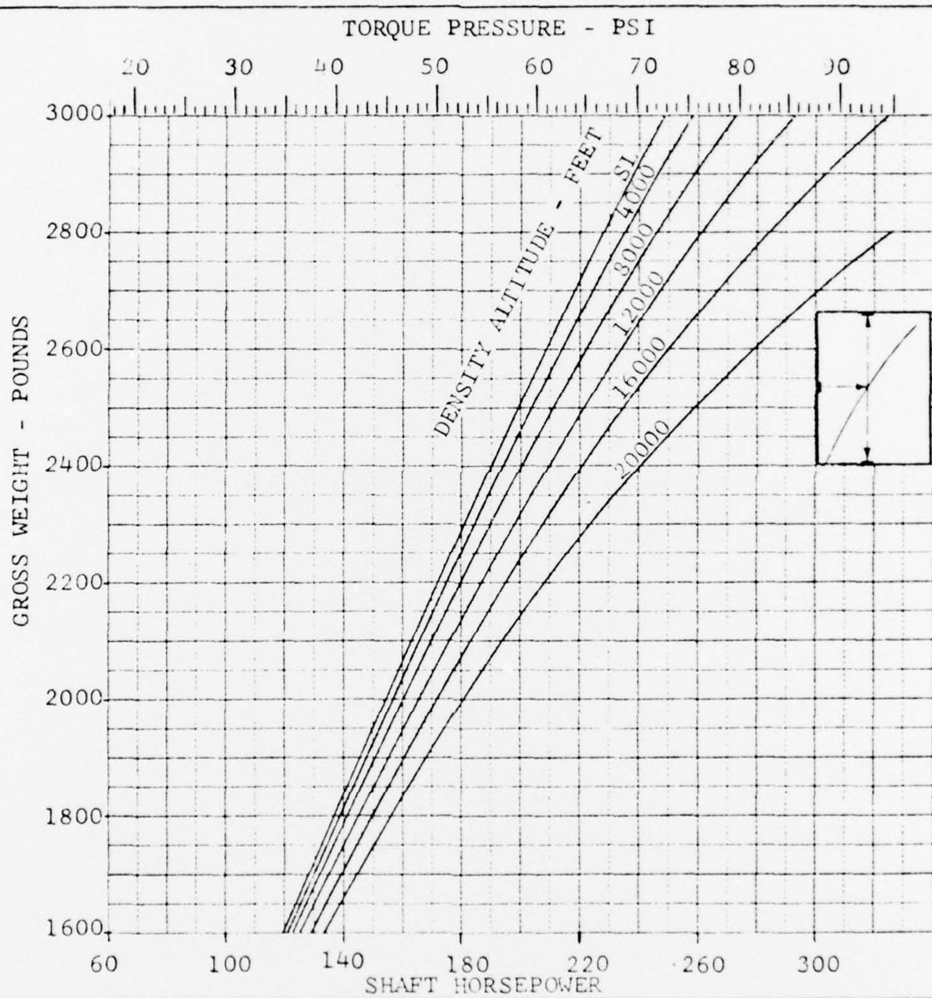
Fuel flow chart

TORQUE AND POWER REQUIRED TO HOVER

OUT OF GROUND EFFECT
ALL CONFIGURATIONS

Model(s): OH-58A
Data as of: JUNE 1971
DATA BASIS: FINAL ARMY FLIGHT TEST (68-30)

Engine(s): T63-A-700
Fuel Grade: JP-4
Fuel Density: 6.5 LB/GAL



AV 089127

Torque and power required to hover OGE

APPENDIX D (U)

SELECTED DATA FROM

ALLISON

ON THE

TURBINE

T63-A-700

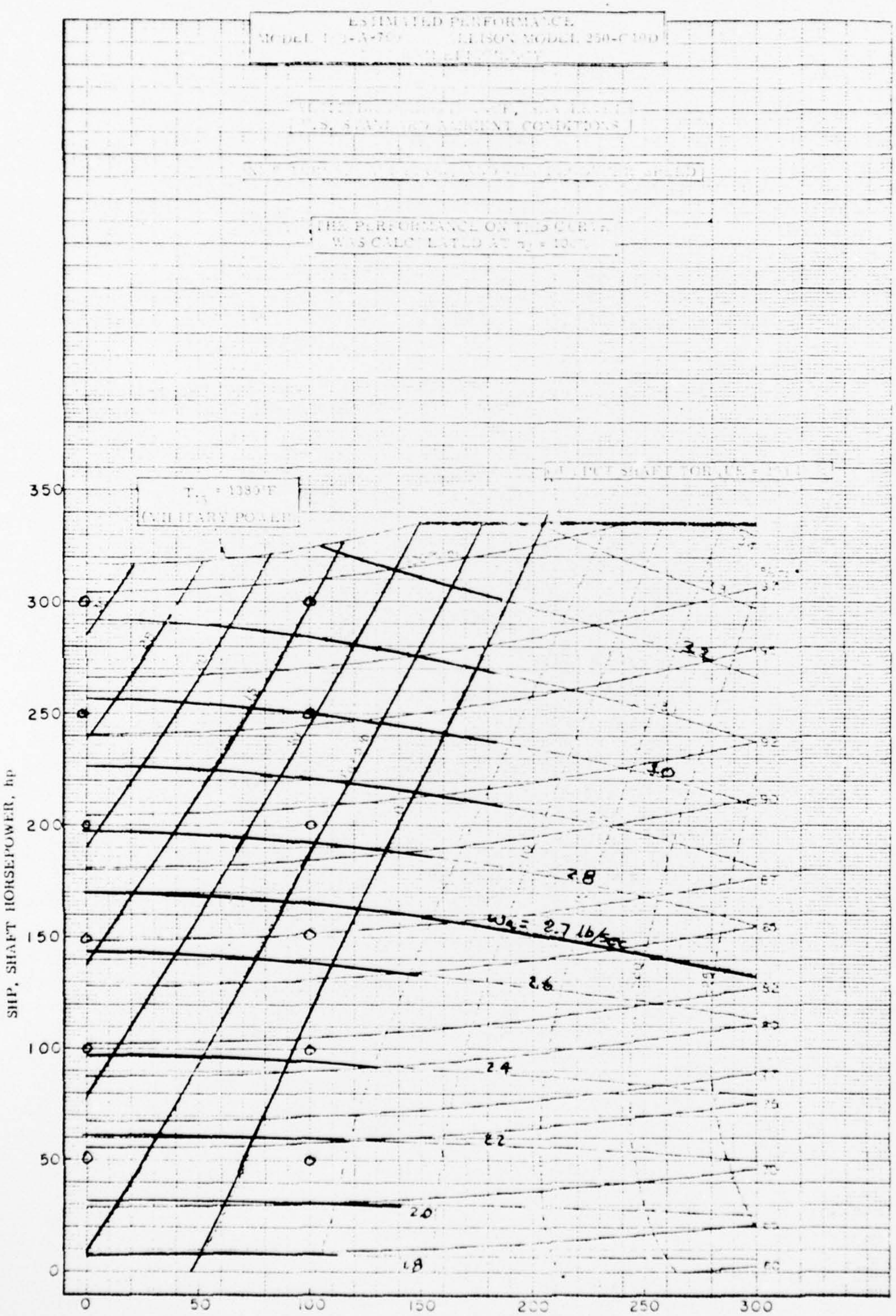


FIGURE NO. 2 V_p, TRUE AIR SPEED, KNOTS

SPEC. NO. 803-A

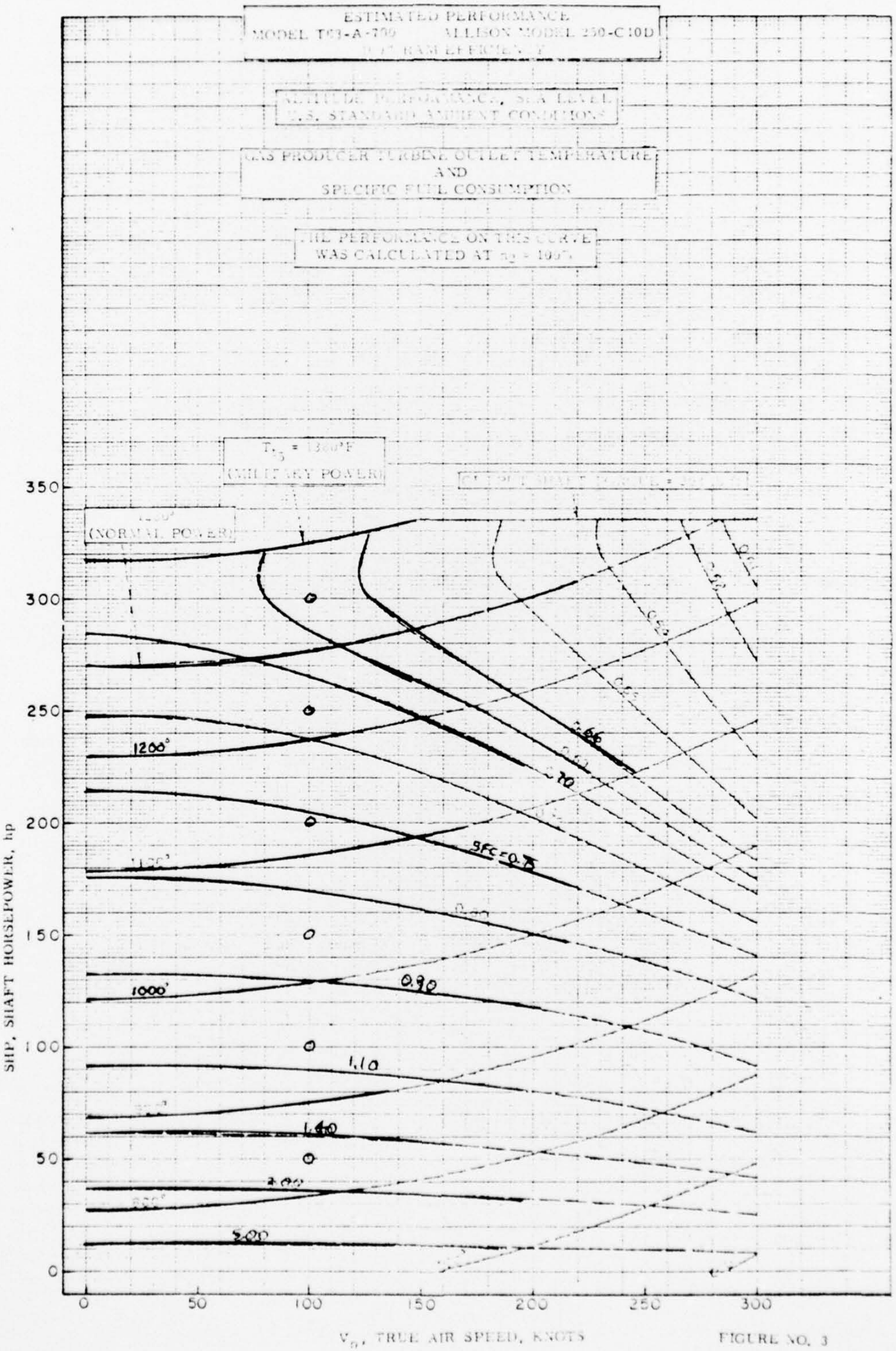


FIGURE NO. 3

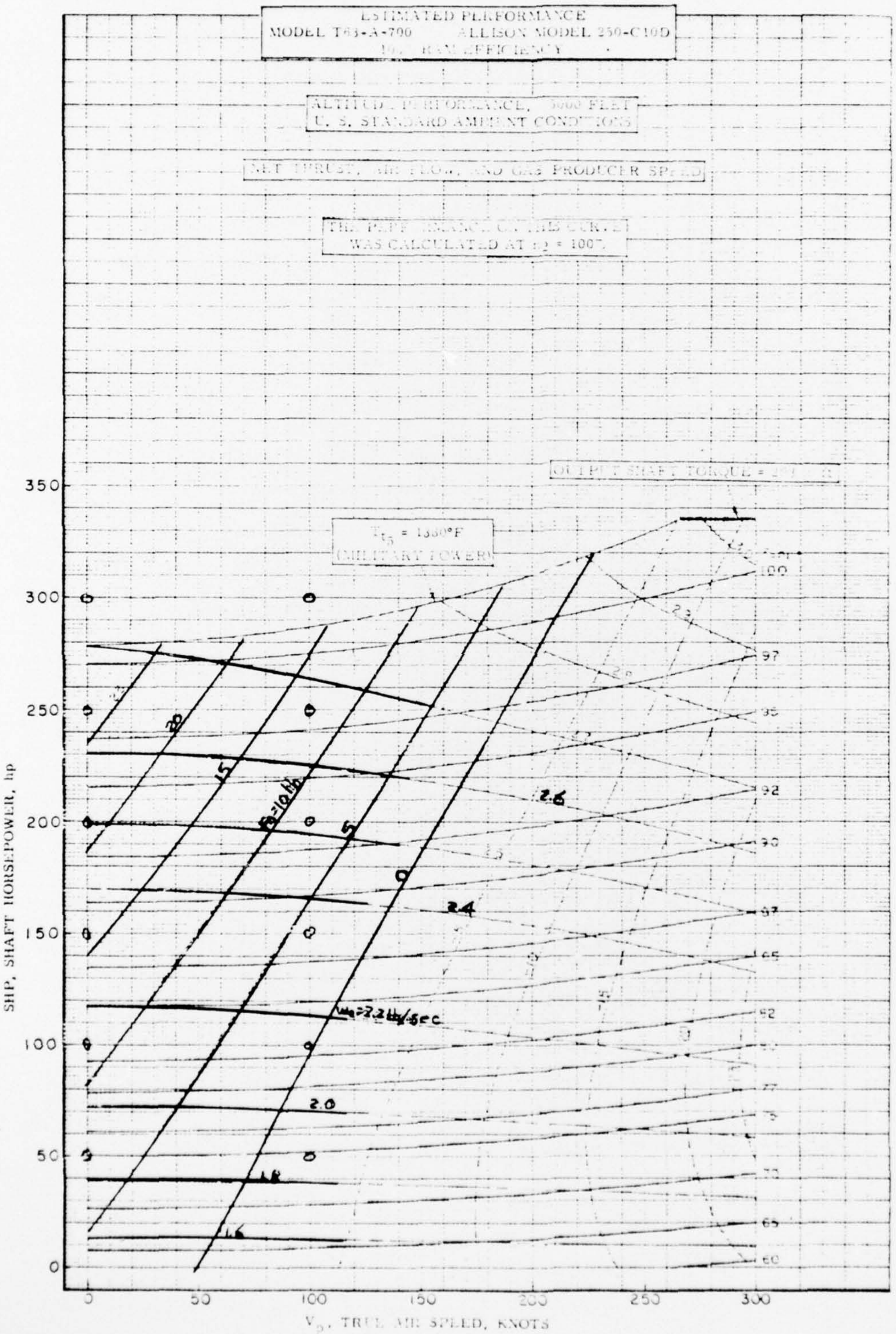
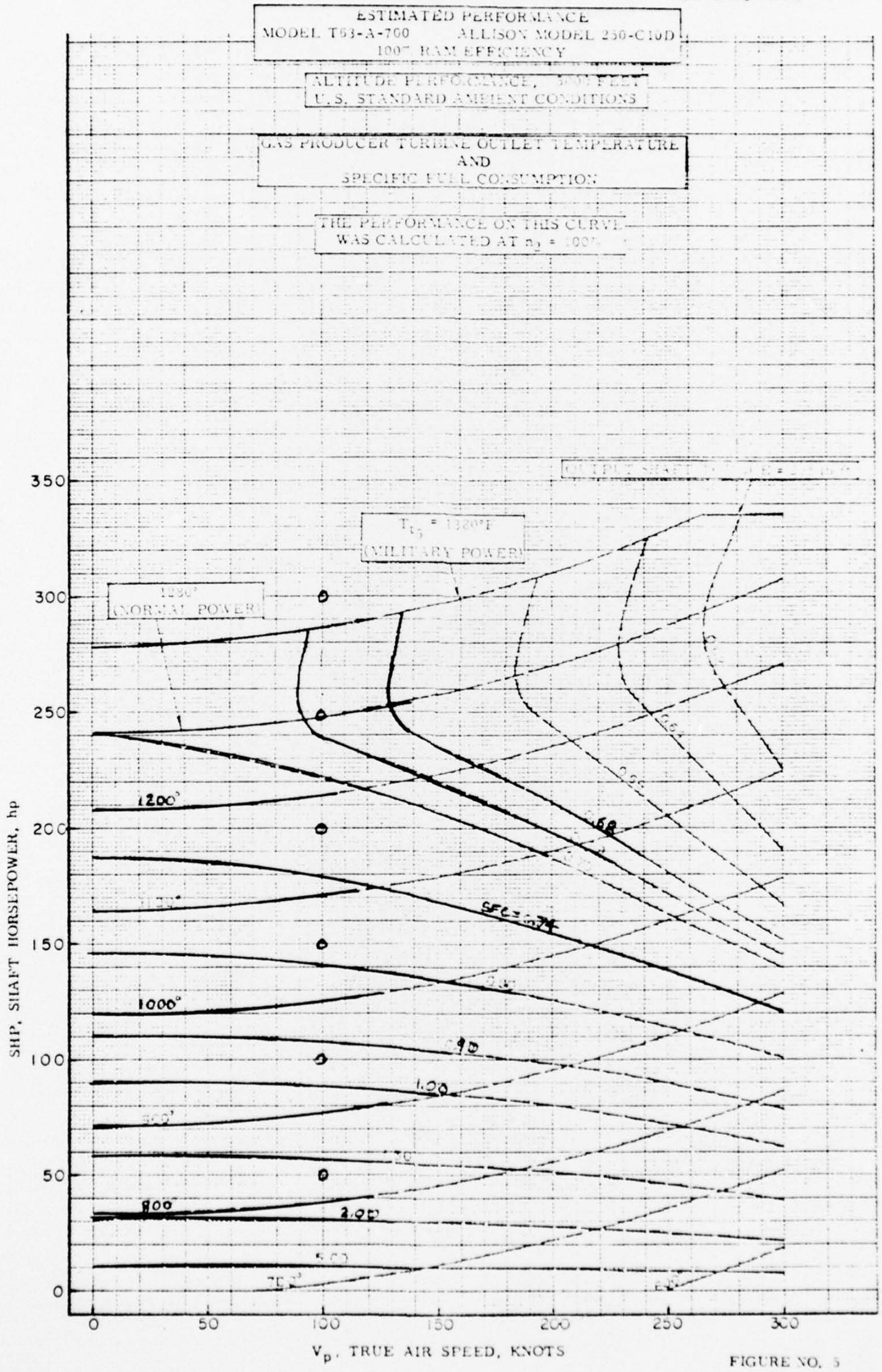

ESTIMATED PERFORMANCE
MODEL T63-A-700 ALLISON MODEL 250-C10D
RAM EFFICIENCY
U. S. STANDARD AMBIENT CONDITIONS
PRODUCER SPEED
WAS CALCULATED AT
T_{t5} = 1380°F
(MILITARY POWER)
OUTPUT SHAFT TORQUE
100
97
95
92
90
87
85
82
77
75
70
65
60
2.0
1.8
1.6
2.6
2.4
0
50
100
150
200
250
300
350
SHP, SHAFT HORSEPOWER, hp
V, TRUE AIR SPEED, KNOTS

FIGURE NO. 4



ESTIMATED PERFORMANCE
MODEL T63-A-700 ALLISON MODEL 250-C10D
100% RAM EFFICIENCY
ALTITUDE PERFORMANCE, FEET
U.S. STANDARD AMBIENT CONDITIONS
GAS PRODUCER TURBINE OUTLET TEMPERATURE
AND
SPECIFIC FUEL CONSUMPTION
THE PERFORMANCE ON THIS CURVE
WAS CALCULATED AT n_2 =
OUTPUT SHAFT
T_{t_5} = 1380°F
(MILITARY POWER)
1280°
(NORMAL POWER)
1200°
1000°
800°
SFC = .74
.68
.90
1.00
2.00
5.00
SHP, SHAFT HORSEPOWER, hp
0
50
100
150
200
250
300
350
V_p, TRUE AIR SPEED, KNOTS

FIGURE NO. 5

SPEC. NO. 803-A

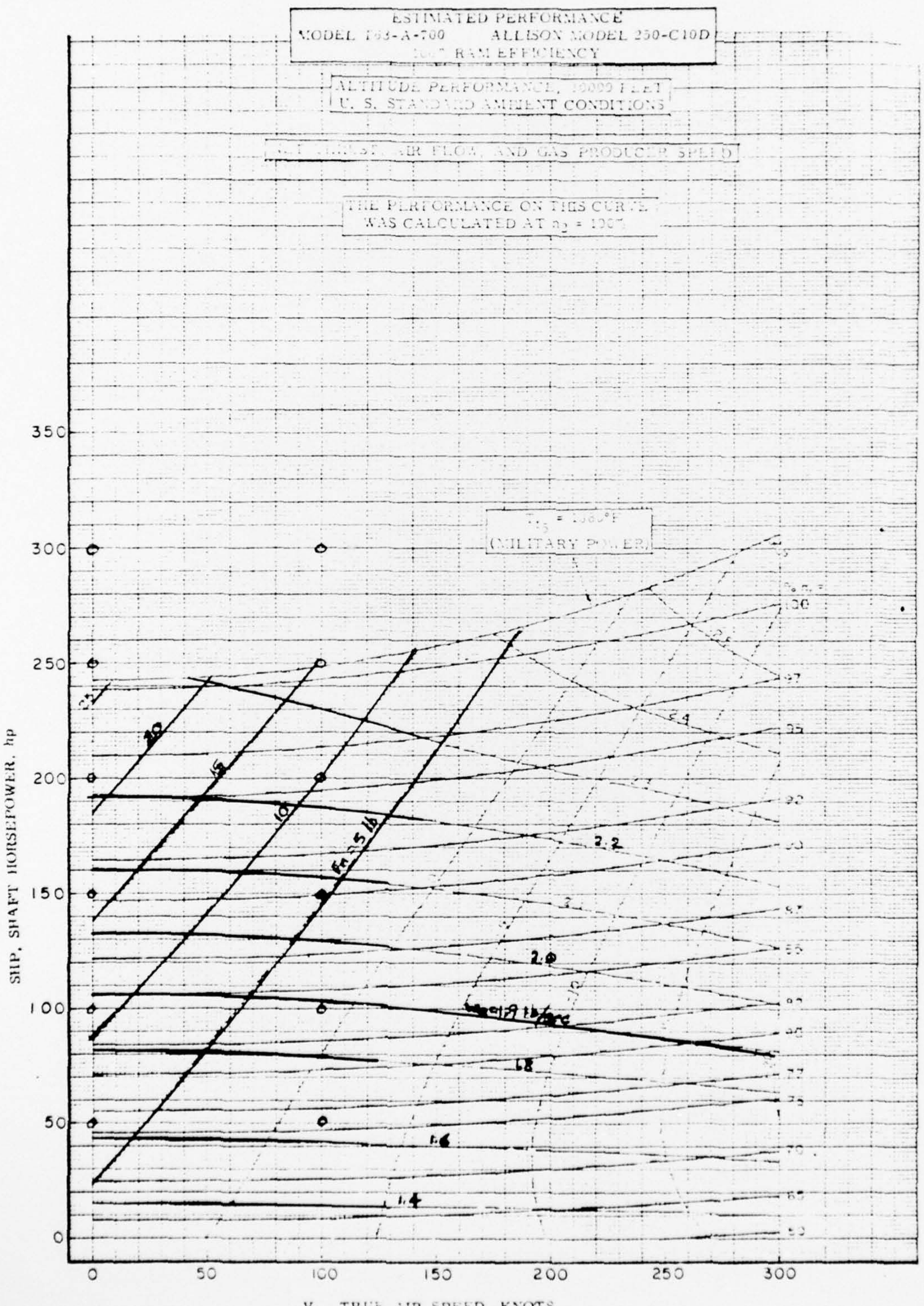


FIGURE NO. 6

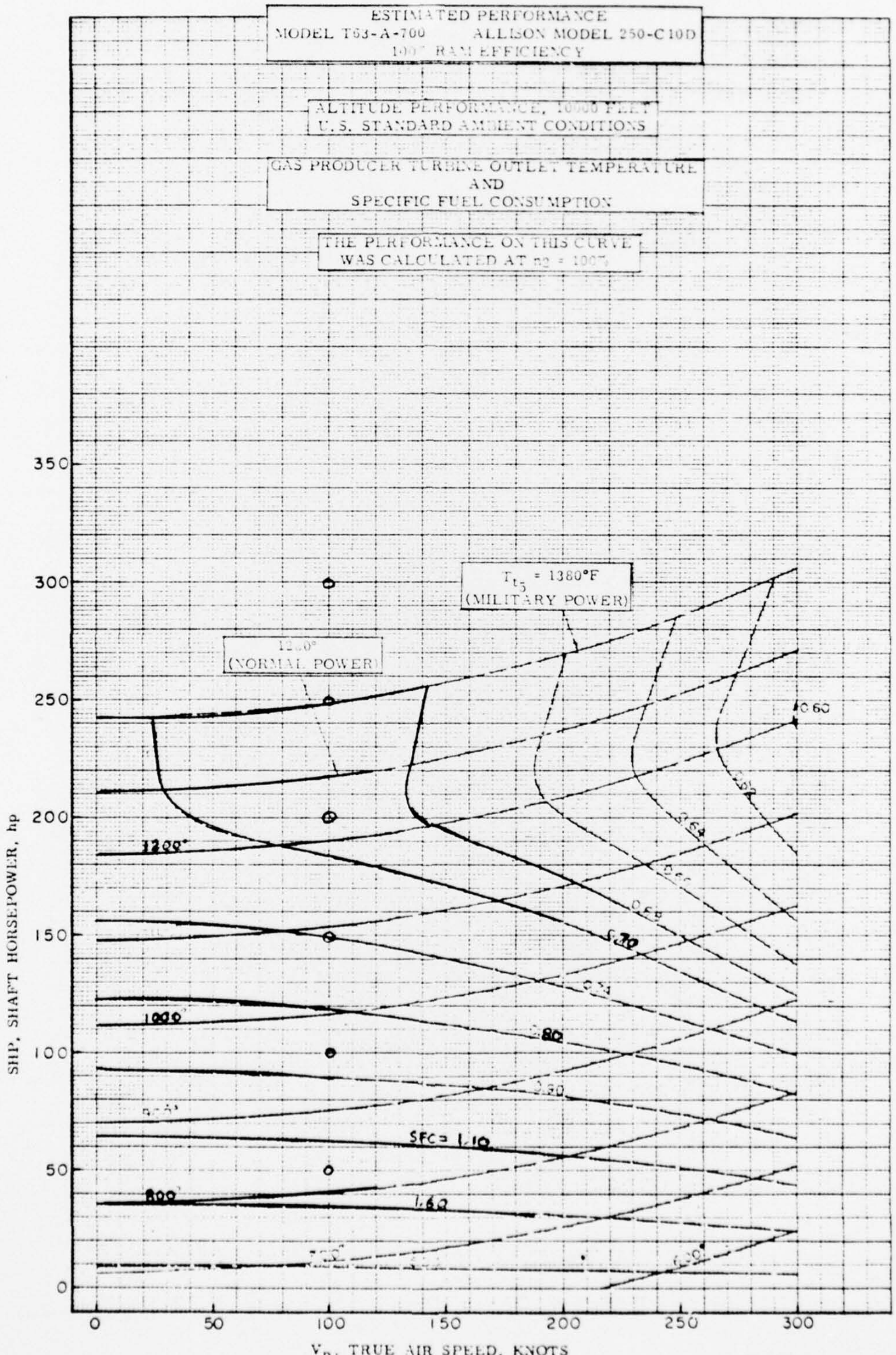

ESTIMATED PERFORMANCE
MODEL T63-A-700 ALLISON MODEL 250-C10D
100% RAM EFFICIENCY
ALTITUDE PERFORMANCE, 10000 FEET
U.S. STANDARD AMBIENT CONDITIONS
GAS PRODUCER TURBINE OUTLET TEMPERATURE
AND
SPECIFIC FUEL CONSUMPTION
THE PERFORMANCE ON THIS CURVE
WAS CALCULATED AT n2 = 100%
T_{t_5} = 1380°F
(MILITARY POWER)
(NORMAL POWER)
1200°
1000°
800°
SFC= 1.10
1.60
.70
.80
.90
0.60
SHP, SHAFT HORSEPOWER, hp
V_p, TRUE AIR SPEED, KNOTS
0
50
100
150
200
250
300
350

FIGURE NO. 7

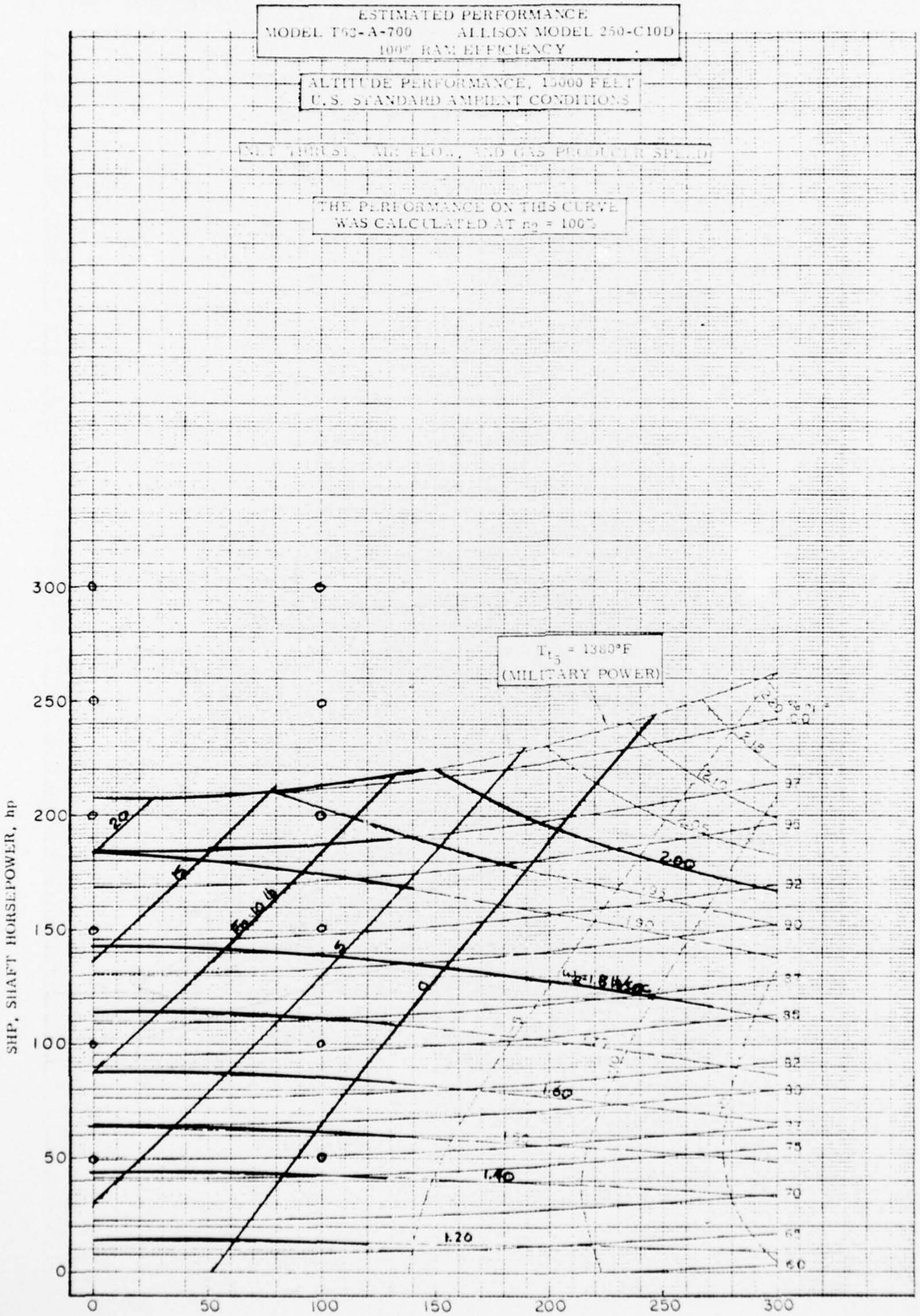


FIGURE NO. 8

V_p, TRUE AIR SPEED, KNOTS

SPEC. NO. 803-A

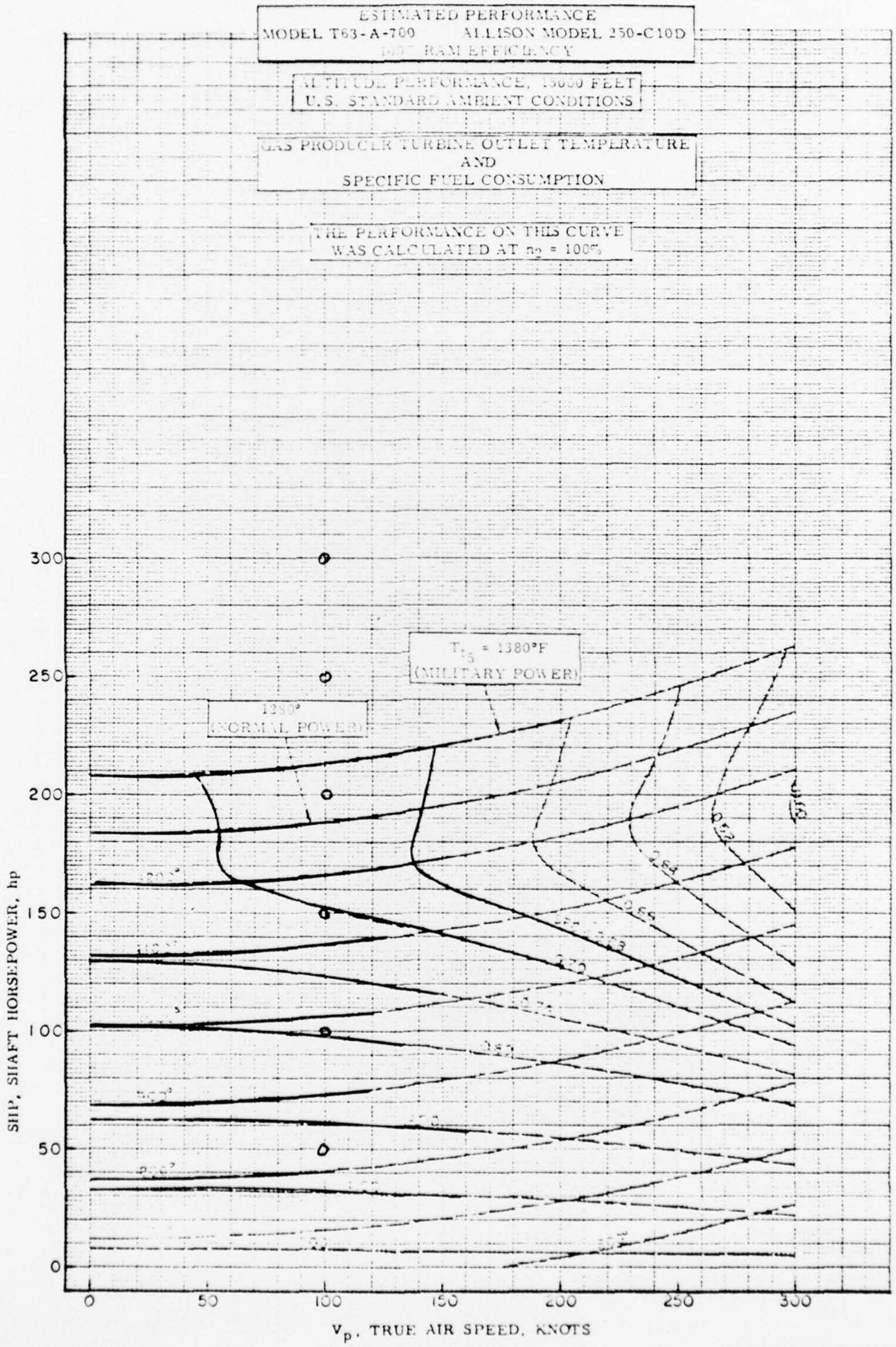


FIGURE NO. 9

SPEC. NO. 803-A

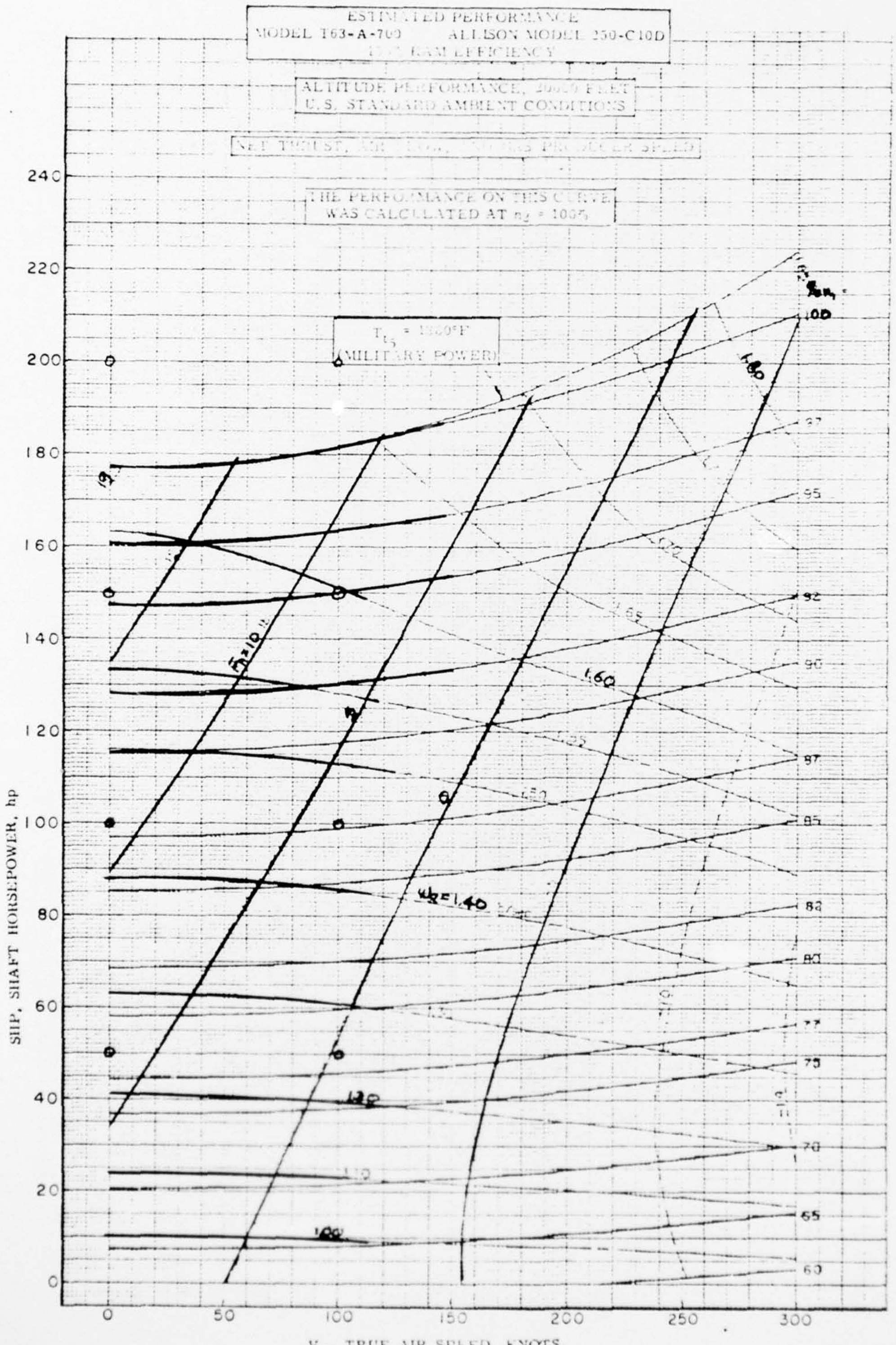
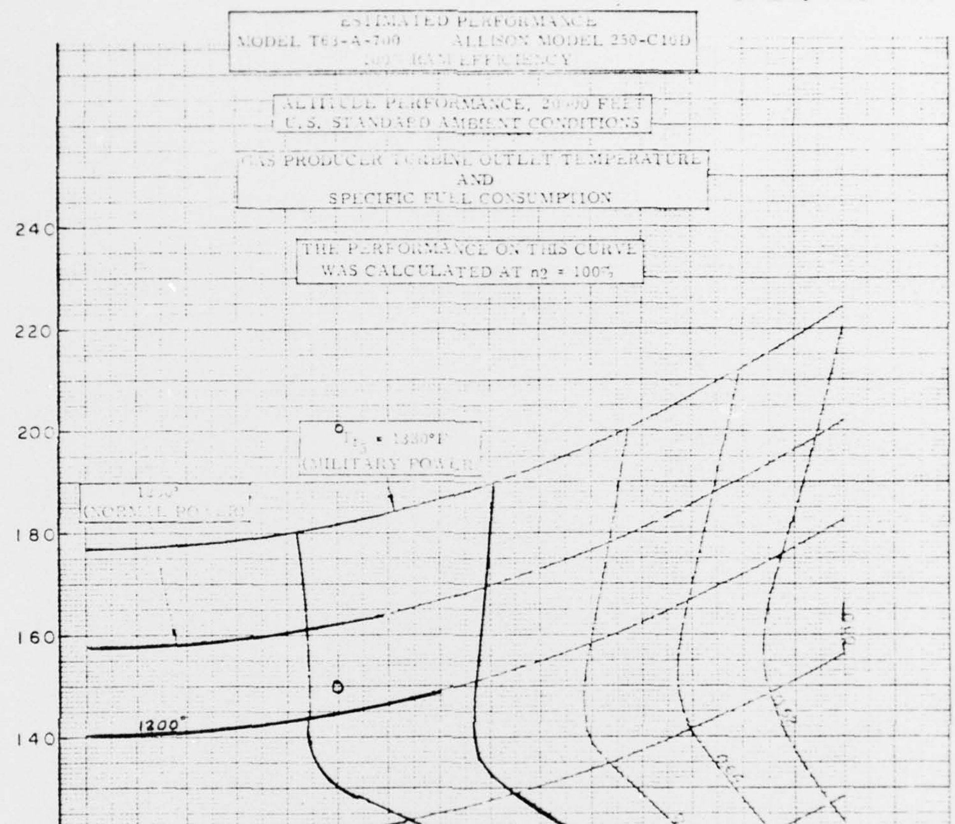


FIGURE NO. 10

UNCLASSIFIED

SPEC. NO. 803-A



V_p, TRUE AIR SPEED, KNOTS

FIGURE NO. 11

UNCLASSIFIED

SPEC. NO. 803-A

ESTIMATED PERFORMANCE
MODEL T63-A-700 ALLISON MODEL 250-C10D

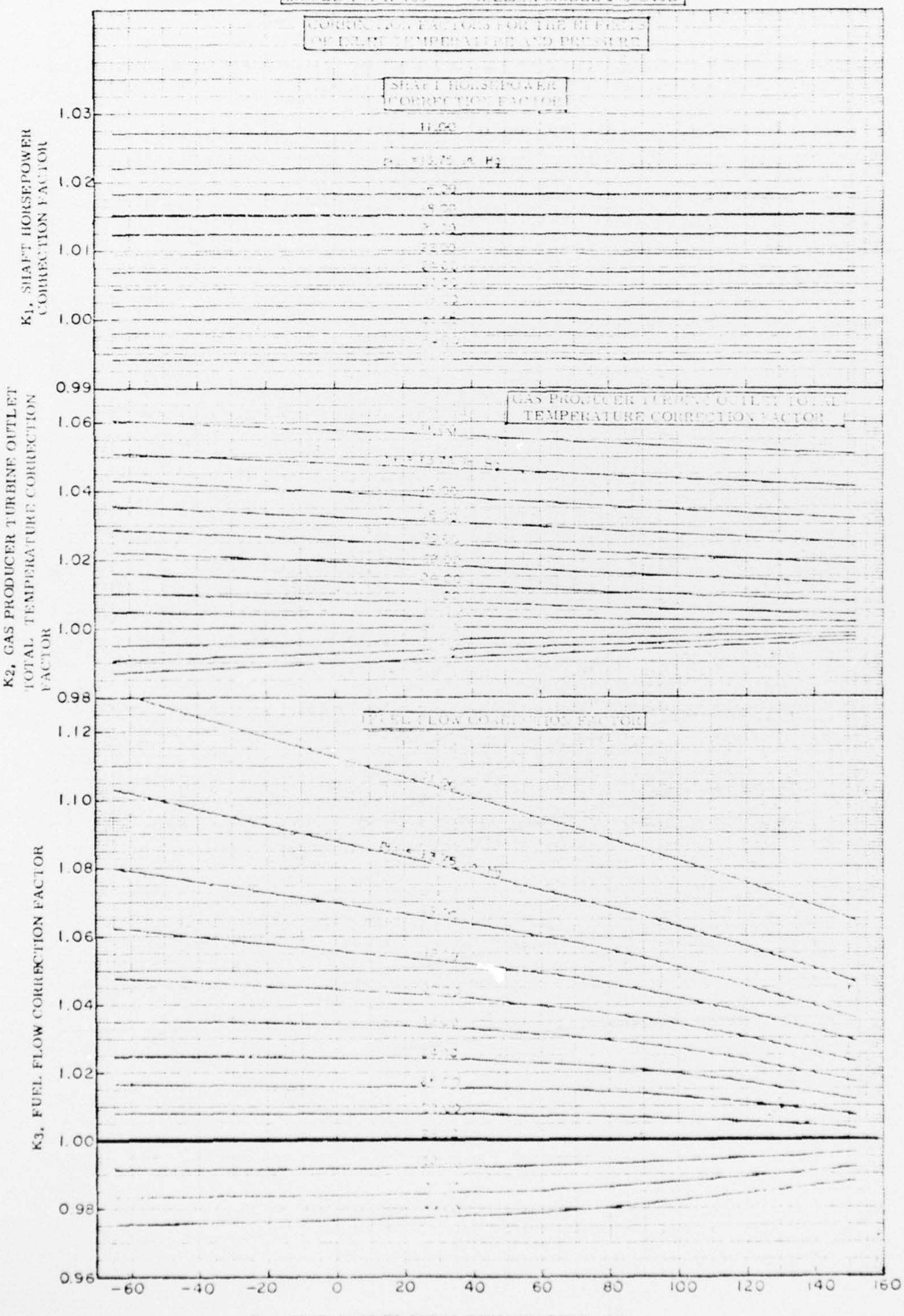


FIGURE NO. 49